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Joseph Leidy

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Contents

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1871 Report on the vertebrate fossils of the tertiary formations of the West. 2

1876 Remarks on fossils from the Ashley phosphate beds. 3

Dr. D. G. Brinton was elected a member.

On favorable report of the Committee, the paper of Dr. Leidy, presented Sept. 15th, entitled "Extinct Mammalia of Dakota and Nebraska," etc., reported in favor of its publication in the Journal.

On favorable report of the Committees, the following papers were ordered to be printed:

Notice of American Species of PTYCHODUS.

BY JOSEPH LEIDY, M. D.

The Cestraciont genus of fishes Ptychodus, so far as known, is confined to the Cretaceous Formations. Remains, consisting of teeth, I have had the opportunity of inspecting from Alabama, Mississippi and Kansas, and although reported to exist in the Cretaceous Formation of Delaware, I have not met with them from that locality nor from the Green Sand, of corresponding age, of New Jersey. The following list comprises all the specimens of American Ptychodus teeth I have had the opportunity of examining.

PTYCHODUS MORTONI.

Agassiz, Poissons Fossiles III. (1833-43), 158, Tab. 25, figs. 1—3; copied in figs. 773, 773a, of Dana's Manual of Geology.

Palate bone of a fish ? Morton: Syn. Org. Rem. Cret. Group. (1834), pl. xviii, figs. 1, 2.

The teeth of *Ptychodus Mortoni* I have seen only from the cretaceous formation of Alabama and Mississippi. Morton, in the work above noticed, figures a tooth, but does not mention the locality from which it was obtained.

Agassiz, in his Poissons Fossiles, gives a good representation of a tooth of this species, from the Green Sand of America, in three views, figs. 1—3, Tab. 25.

Dixon, in his Geology of Sussex, represents two small teeth, (figs. 6, 7, pl. xxi), which he refers to the same species. Though exhibiting some resemblance in character to the American teeth, I think a further comparison is necessary to establish their specific identity.

The teeth of *Ptychodus Mortoni* are well defined in character, and in comparison with teeth of well recognized European species are almost generic in their peculiarity. Though exhibiting some variety, their likeness presents a distinct specific uniformity. Their size of course varies greatly with age and the relative position they occupied with one another in the mouth of the fish.

Viewed from above, the crown is reniform in outline, the long diameter being transverse; the incurvature posterior. The crown rises in the form of a cone with a more or less obtuse summit. The sides of the crown slope to the base and frequently more or less abruptly expand, laterally approaching the latter. The back part is occupied by a wide triangular sinus for the reception of the fore-part of the crown of the tooth which was situated in front of it when the teeth were contained within the mouth. The border of the crown is thick and rounded and dips beneath. At the sinus it is prominent. The summit of the crown presents a prominent crucial ridge, more or less distinct in different specimens. From the cross numerous ridges of about the same thickness diverge upon the sides of the cone, branching in their course, multiplying and becoming finer, and ultimately conjoining upon the base in a fine reticulation extending to the borders of the crown. The coarser ridges vary in their proportionate length in different specimens. The reticulation of the base is most extensive laterally, occupying usually half the breadth of the space between the summit and border. It also occupies the sinus, and is least developed at the fore-part of the crown. The width of the crown approaches double the fore and aft measurement, and the height is usually little less than the latter. The root partakes of the form of the outline of the base of the crown, but is more square and is flat or transversely concave below.

Twelve specimens of teeth of *Ptychodus Mortoni*, from the Cretaceous Formation of Alabama, belonging to the Yale College Museum, have been submitted to my examination by Mr. William M. Gabb. Among them occurs the largest tooth of the species I have seen, and larger than any on record. It is labelled as having been derived from Perry Co., Alabama. The fang and parts of the lateral and back borders of the crown are broken away. In the perfect condition the crown has measured a little over two inches in transverse diameter, one inch and a quarter antero-posteriorly, and ten lines in height. The crushing surface is porportionately less prominent at the centre than in the smaller teeth attributed to the same species, and is more uniformly convex, or less expanded laterally at the base. The borders of the posterior sinus also are less abrupt or defined. The unworn summit presents a crucial ridge, of which the lateral radii are most distinct and directed postero-laterally. From the crucial ridge, numerous ridges, equally prominent, diverge, branch in their course and ultimately conjoin in a fine reticulation at the base af the crown. This reticulation has the greatest breadth at the sides of the crown and is least developed at the fore-part.

Eleven teeth from Uniontown, Alabama, exhibit a gradation in size from less than three-fourths that of the above described specimen down to one little more than a fourth of its diameter. The specimens present a remarkable similitude throughout. Some are proportionately wider fore and aft than others, and the smallest are porportionately higher than the largest ones. The outline of the base of the crown is reniform, with the relation of the longer and shorter diameters varying. The largest specimen has the crown an inch and a half wide, a little over three-fourths of an inch fore and aft, and about half an inch in height. The sides of the crown expand at the base laterally; the fore-part forms nearly a uniform slope, and the back surface slopes to the sinus, which forms a broad triangular depression. The fang is fourteen lines wide, seven lines fore and aft, and three lines in depth.

The crown of a median sized tooth of the series, unworn, measures scant 14 lines wide, 7½ fore and aft, and 6½ high. The smallest specimen has the crown 7 lines wide. 4½ fore and aft, and an equal height. Its base laterally appears more abruptly expanded than in the others. Most of the specimens are unworn and exhibit the characteristic ridges of the crown in a striking manner. In three specimens the coarser ridges are resolved into the reticulation much earlier or nearer the summit than in the others. In one specimen the crown is smooth or totally devoid of ridges, presenting the same appearance represented in figs. 4, 5, pl. xxx, of Dixon's Geology of Sussex, and described as "nascent or incomplete teeth of *Ptychodus*.

Seven specimens of teeth in the Museum of the Academy, from Alabama, exhibit the same characters expressed in the description of those above. They all present an unmistakeable specific likeness, though varying in the proportions of their diameter. The largest specimen has the crown 16 lines wide, 11 lines fore and aft, and 8 lines high. The root is an inch wide, 7 lines fore and aft and nearly 3 lines thick. A second specimen, with the crown 16 lines wide and 9 lines fore and aft, has been proportionately lower than the former. Its summit is worn away, leaving an exposed circular disk of vaso-dentine 4 lines in diameter.

Two specimens in the Museum of the Academy, presented by Prof. Joseph Jones, are from Green Co., Alabama. The larger is perfect and unworn. The crown is scant 14 lines wide, by 7 lines fore and aft, and 5 lines high. The root is 11½ lines wide, 4½ fore and aft, and 2 lines thick.

Two specimens in the Museum of the Academy, presented by Dr. Wm. Spillman, are from Columbus, Mississippi. They present the same character as the Alabama specimens. The larger specimen has the crown 20 lines wide, 10 lines not before characterized. The whale was first driven on shore on its back, and the gular and thoracic regions were seen to be entirely without ridges or plicæ of any kind, but as smooth as any other part of the body, or as the throat of a right whale, Balæna cisarctica Cope, which is not uncommon on the same coast.

This my informant told me was the species known among the whalers as the "Scrag Whale." Though this name is indefinite when applied by whalers of different nationalities, it is probably used with accuracy by those accustomed to any particular region. At any rate I have little doubt that this is the species called by the same name by Dudley, who in 1725 wrote an account of the whales known by the whalers of the coasts of New England. He says it is near the right whale (B. cisarctica) in figure also; "is near akin to the fin-back, but instead of a fin upon its back, the ridge of the after part of its back is scragged with half a dozen knobs or knuckles. He is nearest the right whale in figure and quantity of oil. His bone is white, but won't split." This is published, with an account of the other species known, in the 33d volume of the Philosophical Transactions. He mentions particularly the fin-back and hump-back whales, describing the deep folds of the chin, throat and sides of those genera. There can be little doubt that his "scrag whale" had a smooth throat like the Balænæ, and not a plaited one like the Balænopteras and their allies. By the preceding account it has been shown that the species has but four slender fingers at the carpus; hence it is obviously the type of genus intermediate between Balæna and Megaptera, not hitherto recognized,—furnished, however, with the scapula of Balænoptera.

Captain Atwood, a resident of a part of the peninsula of Cape Cod, Mass., who is a good observer of the life of the ocean, thus writes of the scrag whale in J. A. Allen's Catalogue of the Mammals of Massachusetts, in the Proc. Boston N. H. Soc. for 1868:

"Scragg.—A species of whale known by this name, and nearly allied, if not identical with the right whale, is sometimes taken here. It is the opinion of many of our whalemen that they are not a distinct species, but are the young right whale that lost its mother while very young, and has grown up without parental care, which has caused a slight modification. The most prominent feature is on its dorsal ridge; near the tail there are a number of small projections or bunches, having some resemblance to the teeth of a saw. It has no dorsal fin or hump on its back."

Additional evidence of the existence of this genus has been furnished by the Smithsonian Institution. In accordance with recommendations and directions furnished by the writer, Wm. H. Dall, the enterprising director of the West Coast Scientific Exploring Expedition, originally commanded by Dr. Kennicott, sent to the Institution drawings and descriptive notes of the grey whale of the coasts of Upper and Lower California. The writer has also examined an almost complete set of whalebone, with some other portions of the same species, in the museum of the Essex Institute, at Salem, Mass. The baleen is similar in character to that of the present species, but presents specific differences. The notes of Capt. Dall indicate a long-finned, smooth-throated whale, with a flat-pointed head like a fin-back, and no dorsal fin, but a series of knobs on the posterior region of the back. That it in all respects conforms to the generic type of the Atlantic species, can be determined from the description which follows.

The Atlantic species was named from Dudley's description by the compiler, Erxleben, without his adding to our knowledge of it, Balæna gibbosa. I will follow Dr. Gray in adopting this name. The latter author, in his excellent Catalogue of Seals and Whales in Brit. Mus., refers it, on the basis of the same description, to Balæna, with doubt.

Genus AGAPHELUS Cope.

Fingers four, elongate. Cervical vertebræ ? Lumbar and anterior caudal vertebræ longer than their greatest diameter. Dorsal fin wanting. Gular and pectoral region without folds. Scapula with well developed acromion and coracoid. Baleen narrow, short.

AGAPHELUS GIBBOSUS Cope.

Scrag Whale, Dudley, Philos. Trans. xxxiii., 250, and of The Whalers.
Balæna gibbosa Erxleben, Systema Mammalium 610 (from Dudley), and after him of Gmelin, Bonnatere, Lacepéde, Virey, Gerard, Desmarest & Fischer. Gray, Catal. Brit. Mus. 1850, p. 18, and 1866, p. 90.
Agaphelus gibbosus Cope, Proc. Ac. N. Sci. Phila., 1868, 159.
Balænoptera rostrata Cope, Proc. Ac. Nat. Sci., Phila., 1867, 147.

	Ft.	In.
Total length (estimated) of young	43	
Length to third caudal vertebra	33	
Length of cranium (estimated)	6	10
" mandibular ramus (in curve)	6	
" pectoral limb	4	
Width of " "		15
Length of humerus		11·5
" radius and ulna		17
Posterior margin of scapula		14
Length of coracoid from glenoid cavity		3·3
" glenoid cavity		6·3
Mandible, length from condyle to coronoid		13·5
" depth at coronoid		8·5
" " 2·5 feet from coronoid		4·6

The form of the mandibular ramus is peculiar, and more like that of the Balænoptera rostrata than any other. It is triangular in section, having an inferior angulated ridge, and a broad, slightly convex, superior face, instead of their usual ridge. Such a ridge leaves the coronoid process, but soon turns inwards to form the inner outline. Width of the superior face 3·5 inches. The coronoid process is quite elevated, and turned outwards. In the fresh animal the lower lip included the upper all round. The laminæ of whalebone are placed on a base having a sigmoid flexure. Greatest depth of the gum 1 in. 3 lines. Within each principal lamina are two supplementary laminæ, the intermediate being the narrower, the inner triangular, its intermediate bristles arising from the gum. The bristles of the supplementary plates are longer and finer than those of the outer; in the latter, three series of bristles are enclosed between very thin enamel plates. All the laminæ are thin, five in an inch, and split transversely straight; white cream-colored, with a purplish shade near the centre of the base. The ulna is slender, but furnished with a prominent rounded and flattened olecranon, which is prolonged into a thin cartilaginous plate, formed like the diapophysis of a vertebra, and in the plane of the ulna; this structure appears to have been ossified in the Sibbaldius borealis Fisch., as figured by Dubar In the Agaphelus gibbosus it occasions an abrupt angulation near the basal third of the inner margin of the fin. In the scapula, the coracoid is in its plane, but the larger acromion diverges outwards.

The anterior caudal vertebræ are more elongate than the lumbosacral, less depressed, and with the centra in every way larger. All are sharply keeled on the median line below, with a concave face between the keel and the base of the diapophysis. The caudal and lumbosacral diapophyses are obspatulate, the anterior becoming narrower. The neural spines of the lumbar vertebræ are much elevated, concave above both before and behind, the zygapophysis measuring a point considerably below the middle.

		In.
Third (?) caudal (not perforate)	length centrum	7·3
	depth	6
	width	6·5

	height neural spine	9·5
	zygapophysis	4·3
	length diapophysis (from front base)	3·3
Lumbosacral 1;	length centrum	7·3
	depth	5·3
	width	6·3
	height neural canal	2·5
	width	1·5
	height neural spine	15·3
	zygapophyses	5·5
	length diapophysis	7·5
	greatest width do	5·3
Lumbosacral 2	(more anterior) length centrum	6·3
Lumbosacral 3	(anterior) height centrum	4·3
	width "	6
	length diapophysis	7·7

The ear bone is much compressed, with an inferior carina, toward which the lip of dense bone is suddenly decurved. The longitudinal opening is much contracted, especially anteriorly, where the bone is pinched up into a keel, and there is no abrupt concavity of the inner lip at that point. External surface not very rugose. Total length 3 in. 2·5 lines.

The owner of the whale tried out about one-fourth of the blubber, and procured sixty-five gallons of oil, which would give about four hundred gallons for the whole; the thickness of the adipose layer would not average 4 inches, the greatest thickness was 5 inches.

This species was black above and white below, the sides lead-colored, with longitudinal shades of the darker color; fins, basal half white, terminal black.

AGAPHELUS GLAUCUS Cope, sp. nov.

The points in which this species differs from those of the genus Balæna, previously known, are numerous, and will no doubt be increased on a further knowledge of the animal. The head, between one-fourth and one-fifth of the total length, allies it to the shorter headed species. From the B. australis, the number of dorsal vertebræ, and the color and shortness of the baleen, distinguish it, and no doubt other features will be brought out when we are acquainted with the Cape species. The dorsal serration is not known to occur in any species of the genus Balæna, though said to be characteristic of the A. gibbosus, whose characters I have just given. Two Balænæ have been described as inhabiting the north Pacific Ocean, Balæna sieboldii Gray,[*] and Balæna cullamach Chamisso.[†] Both have been established on figures carved by the natives of the Japanese and Alentian Islands respectively, the former under the supervision of a naturalist, the traveller Siebold. The carving of the B. cullamach, judging from the figure given by Chamisso, can but doubtfully represent any species, but which, if it exist, will rest on the following diagnosis of its describer: "Rictu amplo forma litteræ Scurvato, elasmiis maximis atrocorruleis, spiraculis flexuosis in medio capite, tuberculo in apice rostri (ex imagine) pectore pinnisque pectoralibus albis dorso gibboso sexpinnato."

These are, however, true Balænæ. A species of Agaphelus exists in the Kamtschatkan Seas, according to Pallas, who, however, derives his information solely from wooden models made by Aleutian Islanders. This is not sufficient basis for an introduction to the scientific system, yet Pallas indulges in applying to it the name *Balæna agamachschik*. The pectoral limb of this species is said, however, to be white, with the under side of the flukes, characters not found in the A. glaucus Dr. Gray has already (Catal. Brit. Mus.) indicated that this, if reliable, indicates a genus unknown to him.

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[*] Catalogue Cetaceans, 1865, 96, Fauna Japonica, Temminck & Schlegel, t. 28, 29.

[†] Nova Acta Acad. Caes. xii., p. 251, Tab.

The Agaphelus glaucus is the gray whale of the coasts of California. Two specimens have been examined by my friend, Wm. H. Dall, of the Scientific staff of the U. S. Russian American Telegraph Expedition, one of them near Monterey, and descriptions as complete as the state of the specimens would allow, were made. These, which were sent to the Smithsonian Institution, and placed in my hands by Prof. Baird, are quite sufficient to indicate a whale of a species hitherto unnoticed, and to render certain its future identification.

Specimen No. 1, a skeleton nearly complete.

	Ft.
Length of cranium	10
Of dorsal vertebræ	12
Lumbar and caudal (except of the fluke)	26
? Vertebræ of fluke	? 3
Total	51

Dorsal vertebræ and ribs, thirteen; lumbar and caudal (those in the fluke cut off with it), 28. Scapula, breadth and height not very different, with a short, broad coracoid process; its head opposite first rib. Apparently only four fingers, of which the second is the longest. 145 laminæ of baleen on each side, the longest eighteen inches long; color light yellow.

Specimen No. 2, killed by the "killers," (orca); skeleton still concealed by mass of muscle, etc.

External measurements.

	Ft.
Flukes to anus	14½
Anus to sulcus penis	2
Length of sulcus	1½
Latter to plane of flippers	15
Plane of flippers to end of mandible	15
Total	48

The lower jaw is four inches longer than the upper; the blow-holes are entirely concealed by four dermal plicæ, which accounts for the small misty spout peculiar to the species.

	Ft.	In.
Length of flipper and shoulder	6	
" mouth	10	
" exterior canthus of mouth	1	6
" from chin to eye	10	4
" from eye to margin of canthus		6
Width of caudal flukes	8	9
Width of mouth at canthus	4	
From chin to blow-holes	4	9
Longest baleen		14

Head of humerus opposite third rib; anterior angle of scapula just anterior to first rib. On the vertebral line, for fourteen feet from the caudal flukes, is a series of 18 ridges, like the teeth of a saw, which are altogether dermal in their character. Blubber 4—8 inches thick, thickest near the jaws and on the back near the tail; yield of oil 35 bbls. Epidermis 1 inch thick, carium ·75, with numerous pores. Blow-holes 2—4 inches apart. On each side of sulcus penis a mammary sulcus a few inches shorter.

Color above and below, black, with a gray bloom like a plum. This distinguishes this species from the known Balænæ of the Pacific, which are more or less white on the belly and fin.

Specimen No. 3. A full set of baleen of one side the maxillary is in the Mus. Essex Institute, Salem, Mass. A portion of this, kindly lent me, exhibits the following characters: Compared with that of the A. gibbosus, it is longer and has narrower basis. The plates moderately and simply concave, while those of the latter are sigmoidal, most curved near the outer margin, in cross section. The bristles of the California species are very coarse, varying from one to three series between the enamel plates. The bristles of the A. gibbosus much finer, three series together. Length of the latter 8·5 inches, width at base 4·4 inches. In the Agaphelus glaucus Cope, 22 in. in length, width at base 6 in. In the former nearly 6 in an inch, in the latter 2½. The baleen of the A. gibbosus belonged to the specimen above described.

Two rough outlines accompany Capt. Dall's notes. Both represent the pectoral fin as rather elongate, not pointed, but rather broad at the extremity. A third sketch represents the inferior view, and in it we see two lines for grooves, one on each side the median gular line. This feature, if existing, is interesting, as indicating a tendency to the plicæ of the fin back whales.

This species has usually one calf at a birth, but one was recently taken at San Diego with two fœtuses. Penis 27 in. long, smooth, coarsely papillose, slightly bifid at tip, where the urethra is about the size of a goose quill. (Dall's m. s.)

Oct. 6*th.*

The President, Dr. Hays, in the Chair.

Thirty-five members present.

The following paper was presented for publication:

Notice of some American Leeches. By Joseph Leidy, M. D.

Oct. 13*th.*

Mr. Cassin, Vice-President, in the Chair.

Thirty-four members present.

The following papers were presented for publication:

Notice of some Remains of Extinct Vertebrata. By Joseph Leidy, M. D.

On the Origin of Genera. By Edward D. Cope.

On some Cretaceous Reptilia. By Edward D. Cope.

On variations in Taxodium. By Thomas Meehan.

Oct. 20*th.*

The President, Dr. Hays, in the Chair.

Thirty-six members present.

Dr. F. A. Genth made some observations on the occurrence of cupriferous ores in Texas.

Dr. A. R. Roessler, Geologist at the U. S. General Land Office at Washington, had sent him for examination a specimen from Weatherford, Archer Co., Texas. It was a piece of copperglance, containing 55·44 per cent. of copper, pseudomorphous after wood or a vegetable substance. It resembled so much similar pseudomorphs found in the Permian formation at Frankenberg in Hesse, and elsewhere in Europe, that he pointed out the probability of its occurring also in the Permian formation, and requested Dr. Roessler to obtain fuller details with reference to its occurrence. A few days ago Dr. Roessler received an answer to his inquiries from the General Land Office agent in Texas, with more specimens, and the following report, which he sent to me:

"After traversing the cretaceous and carboniferous series northward of Weatherford, Archer Co., Texas, I was agreeably surprised by a grand panorama of the Permian formation. This system is extensively developed in Russia between the Oural Mountains and the River Volga, in the north of England, and in Germany, where it is mined for its treasures of copper, silver, nickel and cobalt ores. It has not heretofore been known to exist in this State, or it had been mistaken for the Triassic system, which is overlying the former to the south-east. Its hills, which have been traced throughout Archer and Wichita Counties, resemble in shape the copper-bearing or gossan-crested upheavals in Ducktown, Tenn., but they are of a different age and composition. They are nearly barren, and, towering above the most beautiful mesquit prairies fringed by the finely-timbered bottoms of the tributaries of Red River, are exceedingly picturesque. The members of the Wichita System, as far as open to ocular inspection by out-crops or cross-cuts, making allowance for climatic differences, correspond closely with the lower strata, discovered at Perm and Mansfeld, but its mineral resources are evidently more promising. Such numerous veins of copper ore have been traced over the summits and sides of the hills, that hardly a hundred and sixty acre tract could be found without ore on the surface. The ore crops out, as, for instance, on the Isbell Douglass Ball, in such quantity and quality that the mere collection of it, without mining, would prove remunerative. It is supposed that those veins are cotemporaneous with injections at different ages of quartz, trap and porphyry. The vein lodes are parallel with the strata, but there is sufficient evidence that they partake of the nature of true veins. Cupriferous and ferruginous cross-courses, feeders and leads of manganese are often met with. A cross-cut was made to a depth of about fifteen feet upon the Isbell lode, and ten hours work resulted in the raising of 6000 pounds of copper ore. This ore is far superior to the ferro-sulphuret of copper, or copper pyrites, which ore is most generally worked in England, and it is, in fact, more profitable than the native copper as found at Lake Superior. It is easily smelted, and the strata in which it is found can also be more economically excavated than any other in which copper ores occur."

Dr. Le Conte, in continuation, spoke of the occurrence of calamite tinged with copper in the Permian formation of Southern Mexico.

Mr. Gabb mentioned the deposits of grey copper near the Colorado River, in Arizona, scattered over the surface, the debris of metallic veins.

Dr. Leidy remarked, that shad had been brought to our markets, for several years past, during the late autumnal months, which were caught in salt water, perhaps in Delaware Bay or off the Jersey coast. When the shad ascend the river to spawn, their stomachs and intestines appear to contain so little that the question is often asked as to the nature of their food. A shad which Dr. L. had purchased a few days since, on examination, was found to have the stomach full of small fishes. There were 30 of them, from 2 to 4 inches long, and all one species, which appears to be the Sand-launce, *Ammodytes Americanus.*

Oct. 27th.

MR. VAUX, Vice-President, in the Chair.

Twenty-six members present.

Philip S. Wales, M. D., was elected a member.

1871

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Leidy ✓

Wash 1871

Life and beauty were everywhere, and man, the great destroyer, had not yet come; but not all was peace and harmony in this Arcadia. The forces of nature are always at war, and redundant life compels abundant death. The innumerable species of animals and plants had each its hereditary enemy, and the struggle of life was so sharp and bitter that in the lapse of ages many genera and species were blotted out forever.

The herds of herbivores—which included all the genera now living on the earth's surface, with many strange forms long since extinct—formed the prey of carnivores commensurate to these in power and numbers. The coo of the dove and the whistle of the quail were answered by the scream of the eagle, and the lowing of herds and the bleating of flocks come to the ear of the imagination mingled with the roar of the lion, the howl of the wolf, and the despairing cry of the victim. Yielding to the slow-acting but irresistible forces of nature, each in succession of these various animal forms has disappeared till all have passed away or been changed to their modern representatives, while the country they inhabited, by the upheaval of its mountains, the deepening of its valleys, the filling and draining of its great lakes has become what it is.

These changes which I have reviewed in an hour seem like the swiftly-consecutive pictures of the phantasmagoria or the shifting scenes of the [illegible] but the æons of time in which they were effected are simply infinite and incomprehensible to us. We have no reason to suppose that *terra firma* was less firm, or that the order of nature in which no change is recorded within the historic period, was less constant then than now. At the present rate of change—throwing out man's influence—a period infinite to us would be required to revolutionize the climate, flora, and fauna, but there is no evidence that changes were more rapid during the tertiary ages.

Every day sees something taken from the rocky barrier of Niagara; and, geologically speaking, at no remote time our great lakes will have shared the fate of those that once existed at the far West. Already they have been reduced to less than half their former area, and the water level has been depressed three hundred feet or more. This process is pretty sure to go until they are completely emptied.

The cities that now stand upon their banks will, ere that time, have grown colossal in size, then gray with age, then have fallen into decadence and their sites be long forgotten, but in the sediments that are now accumulating in these lake basins will lie many a wreck and skeleton, tree trunk and floated leaf. Near the city sites and old river mouths these sediments will be full of relics that will illustrate and explain the mingled comedy and tragedy of human life. These relics the geologist of the future will doubtless gather and study and moralize over, as we do the records of the tertiary ages. Doubtless he will be taught the same lesson we are, that human life is infinitely short, and human achievement utterly insignificant. Let us hope that this future man, purer in morals and clearer in intellect than we, may find as much to admire in the records of this first epoch of the reign of man as we do in those of the reign of mammals.

IV.—REPORT ON THE VERTEBRATE FOSSILS OF THE TERTIARY FORMATIONS OF THE WEST.

BY PROF. JOSEPH LEIDY.

In the present report the writer has simply given a brief notice of the various vertebrated animals whose fossil remains have been collected in the tertiary deposits of the West. For a full account of most of the extinct mammals which are subjects of notice, the reader is referred to the work entitled "The Extinct Mammalian Fauna of Dakota and Nebraska," published in the seventh volume of the Journal of the Academy of Natural Sciences of Philadelphia. More or less full accounts of the other animals, also the subjects of notice, are published in Owen's Geological Survey, the fifth volume of the Pacific Railroad Reports, the contributions of the Smithsonian Institution, and the Proceedings of the Academy of Natural Sciences of Philadelphia.

The vertebrate fossils collected in Professor Hayden's last two expeditions, though forming part of the material of the report, will be more fully described and illustrated in an extended treatise in future.

The short time allowed for the preparation of the report amid the many duties of the writer, must serve as his apology for its imperfect character.

The tertiary formations of the North American continent west of the Mississippi, so far as they have been explored, in the States and Territories of Kansas, Dakota, Nebraska, Wyoming, Colorado, Idaho, California, and Oregon, have yielded a great quantity of remains of vertebrated animals, indicating different races which existed in earlier ages, and which have entirely passed away. The principal deposits from which the greater number of fossil remains have been obtained are those of the *mauvaises terres* of White River, Dakota, those of the valley of the Niobrara River, Nebraska, and the Bridger Group of rocks, near Fort Bridger, Wyoming. The deposits especially referred to appear to be all of fresh-water origin, and to have belonged to the middle and later tertiary epochs.

Most of the vertebrated remains submitted to the examination of the author are part of the valuable fruits of the geological explorations of Professor Hayden, either engaged in expeditions of others, or under his own control. Many have been obtained in the explorations of Dr. David Dale Owen, Dr. John Evans, Mr. F. B. Meek, Mr. Clarence King, and others.

By far the greater number of vertebrated remains are those of mammals, though some of the same or cotemporaneous formations are rich in the evidences of reptilian life, and likewise those of fishes.

MAMMALIA.

The mammalian remains of the western tertiary formations appear mainly to belong to the miocene period, though many evidently pertain to a later age than the others, and most likely belong to the pliocene period. Perhaps also a few of the remains belong at least to the later part of the eocene period, especially those found in the lowest strata of the *mauvaises terres* of White River, Dakota, and those found in the Bridger Group of tertiary rocks of Wyoming.

The fossil remains of mammals thus far collected in the western tertiary formations indicate upwards of one hundred species, mostly of extinct genera, and many of those peculiar to the North American continent. Notwithstanding the large number mentioned, it is but a meager representation of the extensive faunæ to which they belonged. Probably, also, it is but a small proportion of the number which will be discovered in future explorations. The fossils represent nearly all the orders, especially those of *Carnivora*, *Ruminantia*, *Artiodactyla*, *Perrisodactyla*, and *Solidungula*. The *Rodentia* and *Insectivora* are also fairly represented. No remains of *Quadrumana*, *Cheiroptera*, and, singularly enough, of *Marsupialia*, have been discovered.

CARNIVORA.

The carnivorous order of mammals is well represented by remains in the tertiary deposits of our Western Territories. The number and variety of the fossils indicate a development proportionate to the teeming population of cotemporaneous herbivora which supplied the flesh-eaters with food.

CANIDÆ.

The canine family during the pliocene was represented, as in later times, by several species of wolves; during the miocene period it was represented by an allied and subsequently extinct genus, the *Amphicyon*, which also existed cotemporaneously in Europe.

CANIS,

The genus to which our wolves, dogs, and foxes belong.

Canis sævus.—An extinct species of wolf, probably a near relative, if not the progenitor of the existing American wolf, (*Canis occidentalis*,) is indicated by portions of two lower jaws obtained by Professor Hayden from the sands of the Niobrara River, Nebraska.

Canis temerarius.—A second species of wolf, intermediate in size with the prairie wolf (*Canis latrans*,) and the red fox (*Canis fulvus*;) is indicated by fragments of jaws found in company with the preceding specimens.

Canis vafer.—A species of fox, about the size of the living swift fox (*Canis velox*,) is indicated by portions of jaws obtained by Professor Hayden, in association with the preceding specimens.

Canis Haydeni.—An extinct species, of more robust proportions than any of the living American wolves; indicated by the greater portion of one side of a lower jaw; also found by Professor Hayden in the same locality as the former specimens.

The remains of four species of wolves found in association, in the Niobrara sands, indicate that these ravenous animals were abundant during the later tertiary period. Their number appears to have held a relationship with the cotemporaneous abundance of herbivorous animals.

AMPHICYON.

An extinct genus of carnivorous animals, to which the above name has been given, was established on fossil remains discovered in the middle tertiary deposits of France and Germany. The general form and construction of the skull and the character of the teeth indicate a near relationship in the animals of this genus to the wolves. A dozen species have been indicated as having formerly lived in Europe; one of them having been viewed by Cuvier as a "dog of gigantic proportions."

The remains of two species referable to the same genus have been discovered in the miocene tertiary deposits of the *Mauvaises Terres* of White River, Dakota. They are as follows:

Amphicyon vetus.—A species about the size of the living prairie wolf (*Canis latrans,*) indicated by the mutilated cranium and fragments of jaws, with teeth; discovered by Dr. John Evans and Professsor Hayden.

Amphicyon gracilis.—A small species, less in size than any of the existing American foxes. It is indicated by fragments of jaws, with teeth, and the facial portion of a skull of several individuals; all discovered by Professor Hayden.

HYÆNODONTIDÆ

Is the name given to an extinct and remarkable family of animals, exhibiting a relationship to the canine family on one hand, and the feline family on the other, together with ties to others.

HYÆNODON.

One of the most remarkable extinct genera of carnivorous animals is that to which the above name has been given. It belongs to no existing family, and, indeed, is so peculiar as to have become the type of an independent family. In anatomical character it partakes of those of the wolf, the tiger, the hyena, and the weasel, the raccoon, and the opossum. Originally discovered in France, the remains of five or six species have been obtained from the lower miocene and upper eocene formations of that country. Three American species are indicated by fossil remains obtained in the lower miocene tertiary beds of the Mauvaises Terres of White River, by Dr. John Evans, Dr. Benjamin Shumard, Professor Hayden, and Mr. Meek. These species are as follows:

Hyænodon horridus.—The largest known species, and one of the most sanguinary of terrestrial mammals that has ever existed. Cotemporaneous with a multitude of herbivorous animals, many of which were gregarious in extensive herds, it was no doubt a fearful scourge to them. It is indicated by the greater portions of three skulls, together with fragments of jaws and teeth of other individuals. The size of the animal was about equal to that of the largest black bears. The specimens of jaws and teeth discovered have afforded us a view of the entire dentition of the animal, which is truly formidable. Besides the powerful canine teeth, the series of molars affords the unusual exhibition of three teeth, constructed nearly after the model of the single sectorial tooth of other carnivorous mammals, though the last one alone reaches the full development of the corresponding tooth in the latter.

The true sectorial molars of hyænodon, the last of the series of teeth, are constructed like those of the lion and tiger. These teeth, the broadest and strongest of all, combine the mechanism of the wedge and the scissors, and are admirably adapted to cutting animal tissues, including bones.

The large temporal fossæ occupying the sides of the skull, and separated only by a long and high median ridge, sufficiently prove the great power of the muscles which operated on the long levers of the lower jaw. Certainly no other animal which lived cotemporaneously with this formidable creature could have resisted its power. The skull of the species measures about a foot in length.

Hyænodon crucians.—This is the name given to a species not much exceeding in size the red fox *(Canis fulvus.)* A half dozen imperfect skulls of the animal, together with fragments of jaws and teeth, and other bones, have been discovered. Though small, compared with the preceding species, this one was no doubt equally destructive to the smaller herbivorous animals.

Hyænodon cruentus.—A species thus named, intermediate in size to the two foregoing, is indicated by several fragments of jaws and teeth found in association with the remains of the former.

FELIDÆ.

The feline animals forming the family with the above name were well represented among the carnivores of both the middle and later tertiary periods of Dakota and Nebraska.

PSEUDÆLURUS.

This genus, differing from that of felis or the true cats only in the possession of an additional small tooth to the molar series of the lower jaw, was originally named from remains found in the middle tertiary formation of France.

Pseudælurus intrepidus.—This species is indicated by a well-preserved lower jaw, discovered by Professor Hayden in the pliocene sands of the Niobrara Valley of Nebraska. It was intermediate in size to the panther *(Felis concolor)* and the lynx, *(Felis canadensis,)* and in anatomical character and habits was no doubt very similar.

DREPANODON.

This remarkable feline genus, fortunately for animals of a more peaceful nature, now utterly extinct, during the tertiary period appears to have had a wide range of distribution throughout the earth. Its remains have been discovered in the middle and later tertiary formations of Western Europe, Greece, the sub-Himalayan Mountains of Asia, and of both Americas. Several of the larger species equaled in size the lion and tiger, and, judging from their formidable array of destructive weapons, were of even greater ferocity. In comparison with the existing feline animals they are especially marked by the greater proportionate size and compressed form of the upper canine teeth, which have given to the animals the name of saber-toothed tigers.

Two species of the genus appear to have inhabited Dakota during the formation of the *mauvaises terres* deposits of White River.

Drepanodon primævus.—A species not quite so large as the living panther is indicated by a number of skulls, jaw fragments with teeth, and other bones, first collected by the late Drs. Evans and Shumard, and subsequently by Professor Hayden and Mr. Meek. Two of the skulls that have been found exhibit the marks of conflict with some equally rapacious animal, most probably the largest *Hyænodon*, as the depressions made by the teeth on opposite sides of the specimens exactly correspond with the prints of the canines of the latter.

Drepanodon occidentalis.—The second species, indicated by several jaw fragments, discovered by Dr. Hayden, was about the size of the existing panther.

DINICTIS.

This name has been appropriated to an extinct genus of feline animals, represented by remains, thus far only discovered in the *mauvaises terres* miocene deposits of White River, Dakota. It is nearly allied to the preceding genus, but differs from it in the possession of two additional teeth to the molar series of the lower jaw.

Dinictis felina.—A unique species, indicated by two nearly complete skulls, both discovered by Professor Hayden. The animal was rather less in size than the existing panther, and about equaled the smaller species of *Drepanodon*, with which it was cotemporaneous. It possessed the same formidable character of upper canines as in the latter genus. From the number and disposition of the teeth, according with those of the weasel, it has been called the saber-toothed weasel. The skull measures six and a quarter inches in length.

ÆLURODON.

An extinct genus, probably feline, perhaps canine, distinguished by the above name, is founded on an isolated tooth discovered by Professor Hayden in the pliocene sands of the Niobrara Valley. The tooth is an upper sectorial molar, and is intermediate in character to that of the wolves and cats.

Ælurodon ferox.—The species was nearly as large as the Bengal tiger.

PATRIOFELIS.

This name has been appropriated to another extinct and supposed feline genus, founded on fragments of a fossil jaw obtained by Professor Hayden from the tertiary formation near Fort Bridger, Wyoming.

Patriofelis ulta.—The species was rather larger than our panther. The length of its lower jaw is about six inches.

LEPTARCTUS.

An extinct genus, to which the above name has been given, is inferred to have existed during the tertiary period, from a single tooth discovered by Professor Hayden, in association with remains of extinct equine genera, at Bijou Hill, east of the Missouri River, about ten miles below the mouth of White River, Dakota. The tooth apparently indicates a carnivorous animal allied to the living coati of South America.

Leptarctus primus.—The species was about the size of the raccoon.

NOTHARCTUS.

An extinct genus, with the above name, is founded on a portion of the lower jaw, obtained during the last expedition of Professor Hayden. It was discovered on Black's Fork, and pertains to the Bridger tertiary deposit.

Notharctus tenebrosus.—The species distinguished by this name was about two-thirds the size of the raccoon, to which it was also related.

RUMINANTIA.

The ruminating order of mammals is represented by an abundance of remains in the western tertiary deposits. Most of the members not only belong to extinct genera, but to such as are peculiar to the North American continent.

BOVIDÆ.

Bison.

Our western buffalo, or bison, was probably represented during the post-pliocene or quaternary period by a much larger animal, the remains of which have been found, in association with those of the

American mastodon, both in the eastern and western portions of the continent.

Bison latifrons.—The great extinct bison of America was originally indicated by a portion of a skull discovered on a tributary of the Ohio River about a dozen miles from the famous deposit of bones, Big-Bone Lick, Kentucky. Remains have also been found in the latter locality, on the Brazos River, Texas, and elsewhere. The cranial portion of a skull, apparently of the same species, was discovered in California, by Walter Brown, of San Francisco, and was presented to the Academy of Natural Sciences of Philadelphia. The species was about as large as the living buffalo or arnee of India and Java.

OREODONTIDÆ.

The above name is given to an extinct family of animals, the remains of which, discovered in the Western Territories of the United States, indicate that during the tertiary period it embraced many genera and species. The members of the family in anatomical character exhibit strong suilline affinities, while the structure of their grinding teeth indicate them to have chewed the cud like our ruminating animals. Their feet were constructed nearly as in the hog, and, as in this animal, were provided with four toes.

The skull of the oreodonts approaches in form that of the peccaries. The cranial portion resembles that of the camel, and, as in this, is hornless. The temporal fossæ are large and separated by a median sagittal crest, as in the camel. The orbits are closed behind by an arch, as in the latter, and other living ruminants. Large and comparatively deep depressions occupy a position just in advance of the orbits, as in the living deer family, but no unossified spaces occupy any part of the face. The teeth in both jaws form nearly unbroken arches, a condition in which we find none of the allied living families, and but few of any other living mammalia. Well-developed incisors occupy both jaws, such as exist alone in the lower jaw of living ruminating animals. The canine teeth approach in character most nearly those of suilline animals. The grinders are constructed like those of the living ruminants, resembling most nearly those of the deer family.

OREODON.

The remains of this genus are of all other fossils the most abundant of those which have been discovered in the miocene tertiary deposits of the *mauvaises terres* of White River, Dakota. Two species especially, judging from the great quantity of their remains which have been collected, appear to have formerly existed in immense numbers. They were most likely gregarious, in the manner of the existing peccaries, and, like the modern bison, roamed together in great herds over the extensive prairies of the West. Compared with the latter animal they were insignificant in size, and in this respect approached the former.

Oreodon Culbertsoni.—This species, the remains of which have been discovered in the greatest abundance, was first brought to our notice by Messrs Alexander and Thaddeus Culbertson. These gentlemen, brothers, engaged in the fur trade, were the first to collect fossils from the *mauvaises terres*, and place them in the hands of naturalists. *Oreodon Culbertsoni*, named in their honor, was intermediate in size and appearance to the domestic sheep and the collared peccary. Skulls, fragments of jaws with teeth, and other bones of the skeleton of upwards of a thousand individuals of this species have come under the inspection of the writer. In the large number of specimens representing so many individuals, considerable variation in the details of structure have been noticed. The fossils also exhibit great variety in the condition of preservation. Among them are some crushed in such a way as to indicate that the condition was due to the bite of certain of the powerful carnivores which were contemporaneous with the animals.

Oreodon gracilis.—A small species, about the size of a musk deer; was an associate of the former. It was probably equally abundant, but the greater delicacy of its skeleton rendered it more liable to a variety of accidents insuring destruction.

Oreodon major.—A larger species than either of the former, indicated by a few remains, among them a nearly entire and well-preserved skull, discovered by Professor Hayden in the *mauvaises terres* deposits of White River. The skull measures about ten inches in length; and the animal was about as large as the ordinary wolf or the largest-sized dog. The species is remarkable for the large size of its ear capsules, which not only greatly exceeded in proportion those of the *Oreodon Culbertsoni* and *O. gracilis*, but are larger than in the existing hog. What relationship the inflated or enlarged condition of the ear capsules has with the acuteness of hearing or the habits of animals has not been clearly indicated. The comparative scarcity of the remains of *Oreodon major* in the localities in which those of the preceding species were obtained leads me to suspect that the former was probably not cotemporaneous with the latter, or at least did not inhabit the same places.

A few remains from the *mauvaises terres* of White River, which the writer had referred to two species of oreodon, distinct from the preceding under the names of *Oreodon affinis* and *O. hybridus*, I suspect to have pertained to hybrids; probably of *O. gracilis* and *O. major*.

In 1866, Professor Hayden obtained among a number of remains of *Oreodon Culbertsoni*, from the *mauvaises terres*, a specimen of a skull, agreeing in size, form, and details with that of the species just named, except that it had the ear capsules proportionately as well developed as in *O. major*. I referred it to a distinct species with the name of *Oreodon bullatus*, but I suspect it pertained to a hybrid between *O. major* and *O. Culbertsoni*. It is not unlikely that *Oreodon major* may have lived in a locality skirting that inhabited by the species *O. Culbertsoni* and *O. gracilis*. The intimate relationship anatomically and physiologically would readily allow of the hybridization which has been suspected.

Oreodon superbus.—Last autumn the writer received through the Smithsonian Institution, for examination, a collection of mammalian fossils from the Reverend Thomas Condon, of Dalles City, Oregon. They were mainly collected in the valley of Bridge Creek, a tributary of John Day's River, Oregon. The fossils in general appearance and condition of petrifaction resemble those of the *mauvaises terres* of White River, Dakota.

The greater number and more striking specimens belong apparently to a species of oreodon larger than any of those from the locality last named. The skull of the animal was about fourteen inches in length. The ear capsules are inflated and proportionately as large as in *O. major*. The face is rather more abruptly narrowed in advance of the orbits than in the latter; the infra-orbital arches are proportionately deeper, and the lachrymal depressions are shallower. The teeth have the same constitution as in the *mauvaises terres* oreodons, but the canines and premolars are proportionately wider and thinner, and thus appear of a more compressed character. The inferior canine tooth, at the base of the crown is an inch in breadth fore and aft. The species I have distinguished by the name heading this article.

Mingled with the remains of *O. superbus* are a few fragments, apparently referable to *O. Culbertsoni.*

MERYCOCHŒRUS.

As the name of the genus indicates, a ruminating hog, like oreodon, and pertaining to the same family. It is closely related to the latter genus, and perhaps by many naturalists would be regarded as the same. Its chief differences consist in the proportionately great depth of the infra-orbital arch, the abruptly-narrowed face, the comparatively-shallow lachrymal depression, and the more posterior position of the infra-orbital foramen. The characters thus presented were more sharply defined previous to the recent discovery of a second species of the genus, which is intermediate, and therefore still more nearly approximates the two genera, if it does not merge the one into the other.

Merycochœrus proprius.—The remains of this species were discovered by Professor Hayden, during Warren's expedition of 1857, on the head-waters of the Niobrara River, opposite Fort Laramie. They were embedded in a dull, reddish-brown sandstone, which Professor Hayden refers to the miocene tertiary period. The animal was larger than any of the species of oreodon, except the *O. superbus* of Oregon, which it approximated in size. The jaws are of more robust proportions than in the oreodons, and the infra-orbital arches of greater depth. In this the latter measure nearly two inches; in *O. superbus*, an animal of about the same size, an inch and a half; in *O. major*, three-fourths of an inch.

Merycochœrus proprius appears not to have inhabited the same localities with the oreodons, at least cotemporaneously. I suspect it to have lived at a later period, and perhaps, on the theory of the distinguished philosopher Darwin, may have been the successor by selection of the oreodons.

Merycochœrus rusticus.—A second species of the genus distinguished by his name is indicated by remains recently discovered by Professor Hayden, on the Sweetwater River, eighteen miles west of Devil's Gate, Wyoming Territory. The animal was about the size of *Oreodon major*, but is readily distinguishable through the anatomical characters that separate the two genera to which they belong. The number of remains of *M. rusticus* obtained during a short period from a circumscribed locality indicate the animal to have been abundant.

MERYCHYUS.

Another genus of the oreodont family to which the above name has been given is indicated by a comparative abundance of remains discovered by Professor Hayden during Warren's expedition in 1857. The fossils were found in the loose sands of the Niobrara River, and are regarded by Professor Hayden as being of more recent date than those of the oreodons, the age of the formation being considered as later tertiary or pliocene.

Merychyus is clearly related to oreodon and *Merycochœrus*, and, like the latter, most probably is the successor of oreodon. The construction and form of the skull and teeth are nearly alike in all the genera mentioned.

The true molars or grinding teeth of *Merychyus* are constructed on the same plan as in all ordinary ruminants, recent and extinct, and are intermediate in character with those which have short crowns, as in the other oreodonts and the deer, and those which have long crowns, as in the camel and sheep.

The species of *Merychyus*, during the later tertiary period, appear to have taken the place of the oreodons of the middle tertiary period. The remains discovered appear to indicate three species of the genus.

Merychyus elegans.—A small species, distinguished by this name, was intermediate in size to *Oreodon Culbertsoni* and *O. gracilis*, or was about the size of the existing collared peccary.

Merychyus medius.—This species, indicated by a few fragments, was rather larger than the existing lama of South America.

Merychyus major.—Fragments of jaws and teeth indicate this species to have been about the size of *Merycochœrus proprius*, and nearly as large as the existing camel.

LEPTAUCHENIA.

Another extinct genus of ruminants of the same family as the preceding, distinguished by the above name, was first indicated by a few remains discovered by Professor Hayden in 1855, on one of the tributaries of White River, near Eagle Nest Butte, Dakota. Subsequently, Professor Hayden, during his exploration of 1866, discovered additional and more complete remains of the same genus on White Earth Creek, a tributary of White River, Dakota. The fossils are attributed by Professor Hayden to the miocene formation.

The skull of *Leptauchenia* has the general form and construction as in the preceding genera of oreodonts, and the number, form, and constitution of the teeth are nearly the same.

The ear capsules are proportionately larger than in any of the other members of the family. Large unossified spaces exist at the sides of the face, extending from the forehead and in advance of the lachrymal bones. Similar spaces exist in the living deer and lama, but not in the other oreodonts so far as known.

The true molar teeth or grinders of *Leptauchenia* most nearly resemble those of *Merychyus*, but exhibit differences. The median buttress-like ridges on the outer part of the upper grinders divide the crown to the fangs more completely than in *Merychyus;* and in the lower grinders the crown internally is divided by corresponding ridges, which are nearly or quite obsolete in *Merychyus.*

The fossil remains thus far discovered indicate the existence of three species of *Leptauchenia* during the miocene period. Cotemporaneous with the species of *Oreodon* and *Merycochœrus* they appear to have been the predecessors of the species of *Merychyus* of the pliocene period. They were all comparatively small, and have been distinguished by the following names:

Leptauchenia major.—The largest species of the genus was intermediate in size with *Oreodon Culbertsoni* and *O. gracilis.* The length of its skull was about five and three-quarter inches.

Leptauchenia decora.—Rather smaller than *O. gracilis*, had the skull about four inches long.

Leptauchenia nitida.—The smallest of the species was about the size of the living musk deer. Its skull is three and a half inches in length.

AGRIOCHŒRIDÆ.

Another genus of extinct, hog-like ruminants, allied to the genera of the preceding family, is nevertheless so peculiar that the author has viewed it as the representative of a distinct family to which he has given the above name. Its principal features distinguishing it from the oreodonts are as follows:

The orbits are open behind, or not separated from the temporal fossæ, in which character they differ from those of all known ruminants, recent or extinct, having the same form of grinding teeth. No lachrymal fossæ exist in front of the orbits as in the oreodonts.

The number, relation, and general constitution of the teeth are the same as in the latter; but the grinders or true molars, though constructed on the same plan as in the oreodonts and the ruminants generally, are remarkable for their transversely spreading character, or the comparative shallowness and breadth of their crowns. The last premolar departs from the usual ruminant pattern, the upper having three lobes to the crown, the lower four lobes.

AGRIOCHŒRUS.

Three species of this genus have apparently been recognized, differing little in size, and in this respect approaching *O. Culbertsoni.* The form and general construction of the skull are nearly the same as in the latter. Besides the orbits being open behind, and the absence of lachrymal fossæ, as above mentioned, the face, in comparison with that of oreodon, is proportionately wider and of less depth. The remains of *Agriochœrus* have been discovered in the *mauvaises terres* of Dakota, but are comparatively rare.

Agriochoerus antiquus.—The remains of this species, consisting of fragments of jaws and teeth, together with the facial portion of a skull, of two individuals, were among the first of the mammalian fossils collected in the *mauvaises terres* of Dakota. They were obtained from a fur trader by the late Dr. Hiram A. Prout, of St. Louis, by whom they were submitted to the examination of the writer. Among several tons of fossil bones subsequently collected in the *mauvaises terres* and brought to our notice, only the smallest traces of this species were detected.

The size of the skull was about equal to that of *O. Culbertsoni.*

Agriochœrus latifrons.—This species is indicated by an almost complete skull, obtained by Professor Hayden, in the *mauvaises terres* of Dakota, during his expedition of the summer of 1866. It differed little in size from the preceding species, but is distinguishable by the breadth of its forehead, which is almost one-third greater. Large inflated ear capsules are present in the skull of *A. latifrons*, proportionately as well developed as in *O. major.*

The skull of *A. latifrons* is eight and a half inches long.

Agriochœrus major.—A somewhat larger species than the two preceding, apparently indicated by a few fragments.

CAMELIDÆ.

The camel family at the present time is represented among the indigenous animals of the western hemisphere by the various species of the lama genus of South America. During the tertiary period many members of the same family were largely distributed in the western part of North America. Recently some remains discovered in California, and submitted to the examination of the writer by Professor J. D. Whitney, indicate a species of lama exceeding in size the existing camel. The species has been named *Auchenia* or *Lama californica.*

CAMELOPS

Is the name of an extinct genus allied to the lama, indicated by a jaw fragment found in the post pliocene gravel drifts of Kansas. The species is named *C. kansanus.*

PROCAMELUS.

An extinct genus established on remains discovered by Professor Hayden in the pliocene sands of the Niobrara River, Nebraska. Fragments of jaws and teeth exhibit a near relationship in the anatomical characters of the skull to that of the existing members of the camel family. It possessed a greater number of molar teeth than the camels and lamas. Three species of the genus are apparently indicated by the fossil remains.

Procamelus robustus.—The largest species, founded on a portion of a lower jaw, pertaining to an animal about the size of the living camel. Its teeth were smaller than in the latter, but this difference was fully compensated in the greater number of these organs.

Some additional remains of the same species were subsequently discovered by Professor Hayden, on Little White River, Dakota.

Procamelus occidentalis.—A species indicated by a greater number of fossil specimens than the preceding, was about two-thirds the size of the former. Some remains, apparently of the same animal, subsequently discovered on the Little White River, Dakota, lead to the probability that all referred to the species thus named may belong to the female of the former one.

Procamelus gracilis.—A small species, not larger than the domestic sheep, indicated by several fragments of jaws and teeth.

HOMOCAMELUS.

An extinct genus, closely allied to the former, to which the above name is given, is indicated by several fragments of jaws with teeth, obtained by Professor Hayden in the pliocene sands of the Niobrara River.

Homocamelus caninus.—The species, named from the conspicuous character of the anterior teeth of the upper jaw, was about the size of the living lama.

MERYCODUS.

This extinct genus of ruminants was originally founded on a jaw fragment discovered by Messrs. Meek and Hayden, in 1853, on Bijou Hill, east of the Missouri River. Subsequently Professor Hayden discovered additional and more characteristic remains of the same, mainly consisting of fragments of lower jaws with teeth, on the Niobrara River, and on Little White River.

Merycodus necatus.—The species was smaller than the domestic sheep.

PŒBROTHERIUM,

Another extinct genus of the camel family, was founded on the greater portion of a skull, which was one of the first fossil specimens produced from the great tertiary cemeteries of the West. The specimen was discovered by Mr. Alexander Culbertson, in the *mauvaises terres* of White River, Dakota, and was presented in 1846 to the Academy of Natural Sciences of Philadelphia. The remains of the genus appear to be exceedingly rare, as a very few trifling fragments have been since discovered.

Pœbrotherium Wilsoni.—The species, approximating in size the domestic sheep, is named in honor of Dr. T. B. Wilson, late of Philadelphia, and a distinguished patron of natural history.

PROTOMERYX.

Another extinct member of the camel family, distinguished by the above name, is founded on a jaw fragment obtained by Professor Hayden from the miocene deposit of Bear Creek, a tributary of White River, Dakota. It apparently possessed the same number and arrangement of teeth as the former two genera.

Protomeryx Halli.—The species, about the size of the domestic sheep, is named in honor of James Hall, the eminent geologist and paleontologist.

MEGALOMERYX.

This generic name has been appropriated to a large ruminant apparently of the camel family. It is founded on a couple of specimens of large, inferior molar teeth obtained by Professor Hayden from the pliocene sands of the Niobrara River. The genus is probably the same as that to which our living lama and alpaca belong.

Megalomeryx niobrarensis.—The species exceeded in size the existing camel.

MOSCHIDÆ.

The family to which pertain the musks, or musk-deers at the present period, is chiefly confined to the continent of Asia and the adjacent islands. It was represented during the miocene tertiary period in North America, by an extinct genus to which the following name has been given:

LEPTOMERYX.

The genus was first characterized by a mutilated skull, discovered by Dr. John Evans, in the *Mauvaises Terres* of White River, Dakota. Subsequently Professor Hayden obtained portions of several less well-preserved skulls, together with many fragments of jaws and teeth, partly from the same locality and partly from Bear Creek, a tributary of the Cheyenne River.

Leptomeryx Evansi.—The skull indicates an animal about the size of the musk deer of Thibet. The species is named in honor of its discoverer, the late Dr. John Evans.

CERVIDÆ.

The deer family, so far as known, is poorly represented in the tertiary and quaternary deposits of the North American continent. However, a larger species of deer than any now living is indicated by remains found in association with those of the American mastodon.

CERVUS.

The genus was probably in existence in the pliocene fauna of Nebraska. A few remains, attributed to an extinct species, have been found in the sands of the Niobrara River.

Cervus Warreni.—The species was about the size of the living Virginia deer. It is named in honor of General G. K. Warren, during whose expedition its remains were discovered by Professor Hayden.

ANTILOPIDÆ.

The antelope family appears to have been represented in the pliocene fauna of Nebraska, by a peculiar genus, having furcated horn cores.

COSORYX.

The peculiar genus thus named and just alluded to is founded on several fragments of horn cores—they may be of antlers—discovered by Professor Hayden in the sands of the Niobrara River. A species, apparently of the same genus, has been described under the name of *Antilope dichotoma*, from the tertiary formations of Gers, in France.

Cosoryx furcatus.—The Niobrara species thus named was about the size of the sheep.

CAMELOPERDALIDÆ.

A singular fossil, obtained by Professor Hayden from Dr. Gehrung, of Colorado City, submitted to the writer for examination, leads to the suppositon that it belonged to a large ruminant, probably of the same family as the existing camelopard of Africa. It has been referred to an unknown genus, with the following name:

MEGACEROPS.

The genus is based on a skull fragment, of remarkable character, found in Colorado. The fossil calls to mind the wonderful but also extinct Sivatherium of the Sevalik Hills of India. The specimen corresponds with that portion of the face of the latter animal which comprises the upper part of the nose, together with the forehead and anterior horn cores. As in Sivatherium, all the bones comprising the specimen are completely coössified, and of great comparative massiveness. The genus was probably the American representative of the Sivatherium, which was the largest of all known ruminants. In its bulk and proportions it approached the elephant, and it was provided with two pair of horns and probably a proboscis like the taper.

Megacerops coloradensis.—The species was not so large as the *Sivatherium giganteum* of India, but may be regarded as having been the largest of all the known ruminants of America, recent and extinct.

ARTIODACTYLA.

Under this ordinal name the writer has included the thick-skinned animals or pachyderms of Cuvier, which have an even number of toes, and has excluded the ruminants of the artiodactyle pachyderms of Professor Owen.

SUIDÆ.

The suilline family at the present time is not represented in America by any of the old-world genera, nor at any past time, so far as the observation of the writer is concerned, was it inhabited by them. Notwithstanding many reports of discoveries of remains of the hog and the hippopotamus, the writer has as yet seen no undoubted traces of these animals which pertained to the American continents.

DICOTYLES.

The peccaries appear to have represented in the western hemisphere the hogs of the other part of the world; at least the writer has not yet seen fossil remains which appeared to him as indubitable evidences of the existence at any time of an indigenous species of hog in America. At the present time two species of peccary inhabit South America, and one of them, the collared peccary, extends into North America as far as the Red River in Arkansas.

At an earlier period several species, now extinct, inhabited North America. Professor Hayden found an upper canine tooth of a peccary on the Niobrara River, but its age and reference to a particular species are uncertain. A portion of a skull, found in digging a well, at the depth of thirty feet, in Gibson County, Indiana, indicates a species which has been named *Dicotyles nasutus*. It was rather larger than either of the existing species, and had a proportionately longer and narrower muzzle. Several teeth found in the miocene deposit of Monmouth County, New Jersey, I suspect to belong to the same.

A few remains found in Maryland, Virginia, and South Carolina apparently indicate a species smaller than the collared peccary. It has been named *Dicotyles lenis*.

PLATYGONUS.

This name has been given to an extinct genus of peccary-like animals which appear to have been abundant during the post-pliocene period. Numerous remains of a species, the *Platygonus compressus*, have been found in the lead-bearing crevices of the cliff limestone at Galena, Illinois. An entire skull, as fresh in appearance as if taken from a living animal, and of the same species, was discovered as early as 1805, in a cave in Kentucky. Remains have also been found in Iowa.

ELOTHERIUM.

This is an extinct genus of suilline animals, originally characterized by remains discovered in the miocene tertiary deposits of France, and was first described in 1847. Its nearest allies now living are the hog, the peccary, and the hippopotamus. The remains of two and perhaps three species of the genus have been found in the miocene deposits of the *mauvaises terres* of Dakota.

Elotherium Mortoni.—The remains from upwards of a dozen individuals of this species have come under the notice of the writer. It was about the size of the domestic hog. The skull bears some resemblance to that of the latter animal. Capacious temporal fossæ for the accommodation of powerful muscles, separated by a median crest, give the cranial portion of the skull a decidedly tiger-like aspect. The strong jaws are provided with a full series of seven molars, a canine, and three incisors on each side above and below.

The pointed character of the latter teeth, the long, bear-like canine teeth, and the conical premolars, probably indicate at least a partially-carnivorous habit. The true molars or grinders approach in character the corresponding teeth of the living suilline animals.

The species was named in honor of the late Dr. S. G. Morton.

Elotherium ingens.—The second species, about a third longer than the former, is founded on a few jaw fragments and teeth obtained by Professor Hayden in the *mauvaises terres*.

Elotherium superbus.—A third species, even larger than the former, indicated by an incisor tooth, from Douglas Flat, Calaveras County, California. The specimen was submitted to the writer by Professor J. D. Whitney.

PERCHŒRUS.

An extinct genus allied to the peccary. It is indicated by small fragments of jaws and teeth, from the miocene tertiary deposit of the *mauvaises terres* of White River.

Perchœrus probus.—The species thus designated was about the size of the living *Dicotyles labiatus* of South America.

LEPTOCHŒRUS.

Another extinct genus thus named is also allied to the peccaries. It is indicated by fragments of jaws and teeth found in association with those of the preceding animal.

Leptochœrus spectabilis.—This species was about the size of the collared peccary.

NANOHYUS

Is the name applied to another extinct genus of suilline animals, indicated by a lower-jaw fragment, from the same locality as the remains of the preceding two genera.

Nanohyus porcinus.—The species was about the size of the common rabbit.

MICROSUS.

A small suilline animal of an extinct genus, thus named, is inferred from a jaw fragment with teeth, obtained during the last expedition of Professor Hayden, on Black's Fork of Green River, near Fort Bridger, Wyoming.

Microsus cuspidatus.—The species named from the pointed condition of the tubercles of the teeth was about the size of the common rabbit.

HYOPSODUS.

A fragment of the lower jaw with teeth, found in association with the specimen last mentioned, appears to indicate a hitherto unknown genus to which the above name is given.

Hyopsodus paulus.—The species was about the size of a large hare.

Anoplotheridæ.

This ancient and extinct family is typified by the singular genus *Anoplotherium*, originally described by Cuvier, from remains obtained from the eocene formation of the Paris basin. In the earliest part of the tertiary period it appears to have been the genus which most nearly approached in character the ruminants of later epochs. In *Anoplotherium* the teeth formed closed series in both jaws, as we now observe to be the case in no mammals except man.

TITANOTHERIUM.

This genus is apparently allied to the *Anoplotherium* of Europe, and another extinct genus named *Chalicotherium*, whose remains were discovered in the Sevalik Hills of India.

Titanotherium prouti.—This species is established on remains of a huge animal, the largest of those yet indicated by the fossils obtained in the *mauvaises terres* of White River, Dakota. It approached in size the elephant, and it was no doubt the conspicuous size of its remains which led to its having been the first noticed of all the extinct animals whose bones have been collected in the *mauvaises terres* cemetery.

The first notice of it was published in 1846, by the late Dr. Hiram A. Prout, of St. Louis, who, from the character of the lower teeth, supposed it to belong to the genus *Palæotherium*, originally established by Cuvier from remains obtained from the eocene formation of Paris, France.

Many remains, consisting of fragments of jaws, teeth, and articular ends of different bones of the skeleton, collected by Messrs. Meek, Hayden, and Evans, indicate a nearer alliance of the animal to the companion of the Palœothere, that is to say, the Anoplothere.

The remains of the species, named in honor of its discoverer, Dr. Prout, belong to the lowest beds of the miocene deposits of the *mauvaises terres*, according to the authority of Professor Hayden.

The teeth of Prout's Titanothere formed nearly unbroken rows, though not so completely as in the Anopothere. It appears to have possessed an incisor less on each side than in the latter, and its canines were proportionately larger, differences which induced small breaks or intervals in the dental series. Among living animals, the grinding teeth of the Titanothere approached most nearly in appearance those of the rhinoceros. In the best preserved specimen of the jaws of Titanothere the series of teeth measure nearly a foot and a half in length.

Various fragments of the skeletons of different individuals indicate considerable variation in size, probably due to difference in sex.

Dr. John Evans reported the discovery of the skeleton of an individual imbedded in the rock in the *mauvaises terres*, which measured, in position, about eighteen feet in length and nine feet in height. This appears much too large in proportion to the size of the jaws above referred to, and the measurement is probably greatly exaggerated, if it, perhaps, does not apply to some other and larger animal. The specimens upon which the species *T. Prouti* is established indicate an animal intermediate in size to the Indian rhinoceros and the elephant.

PALÆOSYOPS.

This extinct genus is indicated by some remains obtained during Professor Hayden's last expedition. The specimens consisting of small fragments of jaws, with molar teeth, were found at Church Buttes, and on Henry's Fork of Green River, Wyoming. The remains belong to the Bridger Group of tertiary rocks, probably of miocene age. The genus is closely allied to *Titanotherium* of the *mauvaises terres*, and to *Chalicotherium* of the Sevalik Hills of India.

Palæosyops paludosus.—The only species of the genus approximated in size the common ox.

Anthracotheridæ.

This name has been given to an extinct family of even-toed pachyderms whose types are the genera *Anthracotherium* and *Chæropotamus*, of the early and medial tertiary formations of Europe. It is also represented in the miocene tertiary formation of the *mauvaises terres* of White River by the remains of a genus which had been previously recognized as occurring in England and France.

HYOPOTAMUS.

This genus was established by Professor Owen from some remains found in the eocene deposit of the Isle of Wight. The true molar teeth, or grinders, resemble those of ruminating animals, except that the upper ones present the remarkable character of an additional or fifth lobe introduced between the anterior pair of lobes. The whole number of teeth and the kind correspond with those of the existing hog.

Hyopotamus Americanus.—A species based upon fragments of jaws and teeth discovered by Professor Hayden, who refers them to the lowest bed of the tertiary formation of the *mauvaises terres*. The animal approached in size the common ox.

PERISSODACTYLA.

This name, originally employed by Professor Owen, I have used to include all the uneven-toed pachyderms of Cuvier, except the solidungulate or equine animals. Thus restricted, the order is represented by seven genera, in the tertiary formations of our Western States and Territories.

Rhinocerotidæ.

Among the most interesting paleontological discoveries in this country is that of the former existence of the rhinoceros family on the North American continent. Remains of a number of species have been detected in Dakota, Nebraska, Texas, California, Oregon, Colorado, Wyoming, and traces even in New Jersey.

RHINOCEROS.

The existing species of this genus are now confined to Asia and Africa. Remains of extinct species have been found in great abundance throughout Europe and Northern Asia. The living species are provided with one or two horns; some of the extinct ones were hornless, and have, on this account, been referred to a different genus, with the name of *Aceratherium.*

Rhinoceros occidentalis.—A hornless species, distinguished by the above name, and little more than half the size of the common Indian rhinoceros, is indicated by an abundance of remains in the miocene tertiary deposits of the *mauvaises terres*, of White River, Dakota. Its dentition is the same as in the living unicorn rhinoceroses; that is, it possesses two incisor and seven molar teeth on each side of both jaws.

The length of the skull of this species is one foot and a half.

Rhinoceros crassus.—This species, about the size of the Indian rhinoceros, is indicated by a few fragments of jaws and teeth discovered by Professor Hayden in the pliocene sands of the Niobrara River, Nebraska.

Rhinoceros meridianus.—A third species, intermediate in size with the two former, is indicated by an imperfect molar tooth, discovered by the late Dr. B. F. Shumard in a tertiary formation of Washington County, Texas.

Rhinoceros hesperius.—A fourth species, under this name, has been viewed as distinct from the former ones, and was founded on specimens submitted to the writer by Professor J. D. Whitney. The specimens, consisting of the greater portion of a lower jaw with the teeth, and some fragments of upper molars, were derived from a tertiary deposit of Calaveras County, California. The species was about the size of the *R. occidentalis* of the *mauvaises terres.*

Recently some remains, probably of the same species, were sent to the writer for examination by the Rev. Thomas Condon, who obtained them on the John Day River, Oregon.

HYRACODON.

This genus has been proposed by the writer, founded on abundance of remains of a small rhinoceros, which differs from all others previously described, whether recent or extinct, in the possession of canines and a full series of incisors in both jaws. The genus was also hornless.

Hyracodon nebrascensis.—The only species of the genus indicated was the smallest of its American kindred, and was about the size of the little hippopotamus of Liberia, Western Africa. During the miocene period it existed in great numbers, associated with the *R. occidentalis*, as proved by the abundance of its remains in the *mauvaises terres* deposits. Remains, apparently of the same species, have been discovered in Colorado, Wyoming, and Oregon. The skull of *H. nebrascensis* is about ten inches in length.

HYRACHYUS.

An extinct genus, allied to *Hyracodon*, is founded on a fragment of a lower jaw of a young animal, obtained, during Professor Hayden's recent expedition, on Black's Fork of Green River, Wyoming. In the mature animal seven molar teeth formed a continuous series in the jaws. The upper molars are unknown. The lower true molars resemble those of *Hyracodon*, but the crowns have their constituent lobes more deeply separated externally by an angular notch. The premolars in comparison with the true molars are proportionately smaller than in *Hyracodon.*

Hyrachyus agrestis.—The species was smaller than *Hyracodon nebrascensis*, and was about the size of the larger living peccary. The molar series occupied a space of about three inches. The first premolar has a laterally-compressed conical crown spreading in a slight posterior heel.

Hyrachyus agrarius.—A supposed second species, probably of the same genus, is inferred from the portion of a lower jaw about the size and form of the corresponding part in *Hyracodon nebrascensis.* The specimen was obtained on Smith's Fork of Green River, Wyoming. The jaw below the last molar is about an inch and three-fourths deep. Its ascending portion in front rises vertically, and externally is deeply concave. The molar series, consisting of seven teeth, is broken away in the specimen. The space occupied by the series is about three inches and three-fourths. The true molars occupied a space of full two inches.

Tapiridæ.

The existing members of the tapir family in this part of the world are confined to Central and South America. During the quaternary period, contemporaneously with the well-known mastodon, several species of tapir inhabited North America.

LOPHIODON.

An extinct genus, described under the above name, by Cuvier, from remains found in the middle tertiary formations of Europe, appears also to have existed contemporaneously in North America.

Lophiodon occidentalis.—A species, about the size of the common tapir (*T. terrestris*) of South America, is indicated by a single tooth discovered by Professor Hayden in the *mauvaises terres* of White River. A fragment of an upper jaw, with two teeth, obtained by the Rev. Thomas Condon, from Bridge Creek, Oregon, is perhaps referable to the same species.

Lophiodon modestus.—A small species of the same genus, thus named, is indicated by a single tooth, discovered in Professor Hayden's last expedition, near Fort Bridger, Wyoming.

LOPHIOTHERIUM.

An extinct genus of this name, described by Professor Gervais, from remains found in the eocene formation of France, appears also to have been represented by a small species during the formation of the Bridger Group of tertiary deposits.

Lophiotherium sylvaticum.—The species is indicated by a jaw fragment with teeth, obtained during Professor Hayden's last expedition on Henry's Fork of Green River, Wyoming. The animal was about two-thirds the size of the collared peccary.

Proboscideæ.

Of all extinct animals none are more familiar to the community than the great proboscideans. Their huge bones, strewed over the earth, have excited the attention of the least observant, and in former years were viewed as unmistakable evidences of the earlier existence of a race of giant men. Even now, to the uninformed their remains have not ceased to be objects of wonder and the most convincing proofs that in former ages huge animals roamed over the country where now they no longer exist.

MASTODON.

This extinct genus of elephants appears to have once lived throughout the greater part of the world. A half dozen species inhabited Europe, the same number Asia, two South America, and at least three, if not four or five, North America.

Mastodon americanus.—The great American mastodon appears to have extended throughout the whole of North America during the quaternary period. Its remains are among the most abundant of fossils and have been found in almost every state and territory of the United States. Complete skeletons, together with skulls of others, in a fine state of preservation, are among the most conspicuous and striking objects of several of our museums. It is probable that this species still continued to exist at the time of man's appearance on the stage of life.

Mastodon mirificus.—This species, whose remains were first discovered by Professor Hayden, on the Loup Fork of the Niobrara River, lived at an earlier period than the preceding, pertaining, as supposed, to the pliocene age. It was about the size of the common mastodon.

Mastodon Shepardi.—A third species, probably of miocene age, has been recently characterized from a fragment of a tusk, from Stanislaus County, California. The tusk of the common American mastodon is composed alone of ivory, as in the modern elephants; but the fragment just alluded to presents a broad band of enamel, as in the tusks of the narrow-toothed mastodon of the miocene formation of Europe. The species is named in honor of Professor C. U. Shepard, of Amherst College, by whom the fossil was submitted to the writer.

Mastodon obscurus.—This name has been appropriated to a supposed species, founded on a tooth which was reported to have been discovered in the miocene deposit of Maryland. Fragments of similar teeth from North Carolina and Georgia appear to confirm the distinctness of this species from *M. americanus* and *M. mirificus*. A portion of a lower jaw containing a last molar, like the Maryland tooth, was recently discovered in Contra Costa County, California. This specimen also clearly distinguishes the species from those just named, but we have no evidence to prove that it is not identical with the *M. Shepardi.*

ELEPHAS.

The most colossal of all terrestrial animals, the elephants, are now confined to Southern Asia and Africa. Prior to the *actual* period species existed in Asia, Europe, and North America which are now extinct.

Elephas americanus.—Remains of an extinct species of elephant have been discovered throughout the greater part of the North American Continent. Generally these remains have been viewed as pertaining to the *Elephas primigenius*, an extinct species of Europe and Northern Asia, and which probably also extended into the extreme northwest of North America. There appear now to be sufficient grounds to consider the American elephant a distinct species from the one just named. The late Dr. Falconer, of England, who perhaps more than any one else had studied the characters of the elephant family, supposed that among the remains found throughout North America there were evidences of two species, one of which he called *Elephas columbi*, and the other he viewed as the *E. primigenius.* The writer also thought he recognized a different species from the common one in some remains obtained by Professor Hayden on the Niobrara River. Upon a review of all the material pertaining to the subject, he now considers that the remains of North America, which have been referred to several species of elephant, belong to but one, distinguished by the name heading this article.

SOLIDUNGULA.

This order is now represented by the single genus Equus, of which no living species is indigenous to America. Fossil remains go to show that during earlier geological periods the order was nowhere so well represented as it was in America. The members of the order are divisible into two groups or families, which have been named the *Equidæ* and the *Anchitheridæ.*

Equidæ.

The equine family is represented at this time by nine or ten species of equus, which appear all to be indigenous to Asia and Africa. Other species of the same genus inhabited Europe, Asia, and North America during the middle and later tertiary periods extending into the quaternary period.

EQUUS.

Though no indigenous species of horse appears to have existed on the American continent during the period of man, a number of them inhabited the country just previously and contemporaneously with the great mastodon, the elephant, the giant sloths of both North and South America, &c. Dr. Lund and Professor Owen have indicated several species from remains found in the latter continent. A number of species have likewise been indicated from remains pertaining to the pliocene and quaternary deposits of North America.

Equus fossilis.—This name has been appropriated to a species whose remains are found in the quaternary deposits of Europe and Northern Asia.

By many the species is supposed to have been the ancestor of the common domestic horse. A few remains found in the frozen cliffs of Eschscholtz Bay, Alaska, in association with remains of the extinct northern Asiatic elephant, are supposed to belong to the same species.

Equus major.—Remains of a species of horse have been discovered in the United States, in association with those of the mastodon, &c. The arrangement of the enamel folding in the upper molar teeth is of a more complex character than in the domestic horse. The species was larger than ordinary varieties of the latter, which led to its being named *Equus major*, though it did not exceed in size the English dray horse.

Equus fraternus.—This name has been proposed for a second species, based on remains found in association with those of the former, together with those of the mastodon, &c., although they are neither distinguishable in size nor details of form from corresponding parts in the domestic horse.

Equus excelsus.—A third species, whose remains are found in the pliocene deposits of the Niobrara River, was about the size of the domestic horse. Its remains have also been found in California and Oregon. The grinders of this species differed in the arrangement of their enamel from those of the domestic horse in the same manner as do those of the ass.

Equus pacificus.—Another species, indicated by remains from California, was about the size of the English dray horse. The arrangement of the enamel folds of its molar teeth is of the utmost comparative simplicity.

Equus parvulus.—This name has been assigned to a supposed diminutive species, by Professor Marsh, on some remains found in a tertiary deposit of Antelope Station, Nebraska, four hundred and fifty miles west of Omaha. It probably pertained to the succeeding genus.

Equus conversidens—Equus tau.—These are the names of two species recently indicated by Professor Owen, of London, from remains discovered in the tertiary deposits of the valley of Mexico.

PROTOHIPPUS.

An extinct genus of equine animals, distinguished by the above name, was originally characterized from remains discovered by Professor Hayden in the pliocene sands of the Niobrara River. Remains of the same genus have likewise been found in South America, but were referred to species of the former genus by Dr. Lund and Professor Gervais. Professor Owen, recognizing their distinction, has recently referred them to a different genus with the name of *Hippidion.* The remains from the Niobrara River indicate three species of the genus, all of which were smaller than the domestic horse.

Protohippus perditus.—This species approximated in size the ass.

Protohippus placidus.—This second species was not more than two-thirds the size of the former one.

Protohippus supremus.—A third species, intermediate in size to the ass and the domestic horse, is indicated by some remains, found by Professor Hayden in 1866, on the Little White River, or the South Fork of White River, Dakota.

The South American species of the genus have been named *Protohippus arcidens*, *P. principalis*, and *P. neogæus.*

HIPPARION.

This is the name of an extinct genus of equine animals, whose remains have been found in the middle and later tertiary deposits of Europe, Asia, and North America. The skeleton was constructed on the same general plan as in the preceding genera, but in addition to the well-developed toe or hoof, which supported the animal, it possessed an additional pair of toes to each foot. These, however, were not sufficiently developed to touch the ground, but projected behind and laterally like the rudimental toes of hogs and ruminants. The arrangement of the enamel in the molar teeth is of a more complex character than in *Equus* and *Protohippus*. A species is indicated by remains found in the Ashley River deposits of Charleston, South Carolina. It was not more than about half the size of the ass, and has been named *Hipparion venustum*.

Hipparion occidentale.—This species, about the size of an ass, is indicated by remains which were found in the *mauvaises terres* of White River, Dakota; but which clearly do not belong to the miocene formation of that region. They pertain to a superficial portion of the tertiary deposit, cotemporaneous with the pliocene deposits of the Niobrara River.

Hipparion speciosum.—A supposed second species, nearly the same size as the preceding, is indicated by molar teeth found at Bijou Hill, on the Missouri River, and in the pliocene sands of the Niobrara River. A fragment of a tooth, likewise apparently belonging to this species, was found in digging a well, at the depth of forty feet, in Washington County, Texas.

Hipparion affine.—A third species, also about the same size as the preceding, is indicated by teeth discovered by Professor Hayden in the pliocene sands of the Niobrara River. The enamel folding of the upper grinders is of a simpler character than in the former species.

Hipparion gratum.—This species, based upon a number of teeth obtained by Professor Hayden in the pliocene sands of the Niobrara River, was considerably smaller than the other species with which it was associated.

MERYCHIPPUS.

Another extinct equine genus, has permanent molar teeth like those of *Protohippus*, but the skull presents deep lachrymal depressions in advance of the orbit, as appears also to be the case in *Hipparion*, but which, in the former, as in the true horse, are absent. The temporary teeth of *Merychippus* resemble more nearly in appearance the permanent ones of the members of the next family than they do those of the other known equine genera. It was from the remarkable resemblance of these to the large grinders of ruminating animals that led to the adoption of the name of *Merychippus*, which literally signifies ruminating horse. The name, however, refers to the resemblance alone, and does not indicate that the animal partook of the peculiar habits of the ruminants.

Merychippus insignis.—This species, about the size of the ass, was originally established on a jaw fragment, containing teeth, which was discovered by Professor Hayden at Bijou Hill. Many additional remains, referable to the same species, were subsequently found in the pliocene sands of the Niobrara River, during Warren's expedition in 1857.

Merychippus mirabilis.—This second species, rather larger than the preceding, is indicated by remains discovered by Professor Hayden in the pliocene sands of the Niobrara River and on Little White River, Dakota.

Anchitheridæ.

This extinct family of three-toed, horse-like animals, has for its type the genus *Anchitherium*, the first known species of which was described by Cuvier under the name of *Palæotherium aurelianense.* Its remains were obtained from the miocene tertiary deposits of France. Lartet and DeBlainville call the same animal *Palæotherium hippoides*, or horse-like Palæothere.

In the *Equine* family the teeth have long crowns, which are gradually protruded as they are worn away; in the *Anchitherine* family the teeth have comparatively short crowns, which are quickly protruded and inserted into the jaws by long fangs. Their skeleton in general form closely approximates that of the horse, and most nearly that of *Hipparion.*

ANCHITHERIUM.

This genus is represented in the miocene deposits of our Western Territories by two species.

Anchitherium Bairdi.—The remains of this species are comparatively abundant, in association with those of oreodons, rhinoceros, &c., in the *mauvaises terres* of White River, Dakota. The skull of the species is a miniature form of that of the horse, except that the face is proportionately shallower. Its length is rather less than seven inches. The size of the animal was about half that of the domestic horse. The species was named in honor of Professor Baird, of the Smithsonian Institution.

Anchitherium Condoni.—A second species is inferred to have existed from a fragment of an upper jaw with a mutilated tooth, discovered by the Rev. Thomas Condon, of Dalles City, on Bridge Creek, a tributary of John Day's River, Oregon. It was rather larger than the preceding species, and is named in honor of its discoverer.

HYPOHIPPUS.

An extinct genus to which this name is given is represented by the following species:

Hypohippus affinis.—Established on a single tooth, indicating an animal about the size of the domestic horse.

ANCHIPPUS.

Another extinct genus, allied to the preceding, is represented by the following species:

Anchippus texanus.—The species is established on a molar tooth obtained by the late Dr. Shumard in Washington County, Texas. It was found in digging a well at the depth of 50 feet in a sandstone supposed to be of miocene age. The animal indicated by the tooth was rather smaller than the ass.

PARAHIPPUS.

A fourth genus of the extinct *Anchitherine* family, named as above, is indicated by some teeth discovered by Professor Hayden in the pliocene sands of the Niobrara River. The teeth resemble in their characters those of *Anchitherium* more nearly than they do those of any of the equine genera; nevertheless they exhibit more complexity than in the former or any other member of the same family.

Parahippus cognatus.—The species thus designated is established upon an incomplete series of well-preserved teeth. The animal was about a third less in size than the ass.

RODENTIA.

The order of gnawing animals is represented in the tertiary formations of the West by half a dozen genera, most of which are extinct. The comparative smallness of the animals of this order renders their remains more liable to total destruction than those of larger animals, and also to their escaping notice when preserved. No doubt many remains of unknown species and genera will be discovered in future explorations of the tertiary deposits.

Leporidæ.

The hare family is represented in the miocene formation of the *mauvaises terres* by a peculiar genus, which probably was the remote ancestor of our rabbits.

PALÆOLAGUS.

The genus is established on a number of fragments of jaws and teeth discovered by Professor Hayden at the head of Bear Creek, a tributary of the Sheyenne River, Dakota. Palæolagus had the same number of teeth as in the rabbit, but the first lower molar is composed of a double column, as in the other molars, whereas in the latter it has an additional column.

Palæolagus Haydeni.—The species, named in honor of its discoverer, was rather less in size than our common gray rabbit.

Sciuridæ.

The family of the squirrels and marmots was represented by a peculiar genus, whose remains were discovered by Professor Hayden in association with those of the former. Similar remains were subsequently obtained from the *mauvaises terres* of White River. The genus is distinguished by the following name:

ISCHYROMYS.

The skull of the genus approaches most nearly in form that of the living beaver, but the teeth more nearly resemble those of the squirrel.

Ischyromys typus.—The species was about the size of the common muskrat.

Castoridæ.

The beaver family is represented both in the miocene and pliocene formations of Dakota and Nebraska.

PALÆOCASTOR.

A rodent or gnawer, to which this name is given, is founded on several incomplete skulls, together with a number of fragments of jaws with teeth, obtained by Professor Hayden in the miocene deposit of the *mauvaises terres* of White River, Dakota.

Palæocastor nebrascensis.—The species was about half the size of the existing beaver.

CASTOR.

The sole representatives of this genus now living are the American and the European beaver.

Castor tortus.—An extinct species, thus named, is indicated by a portion of a skull, with teeth, found by Professor Hayden in the pliocene sands of the Niobrara River. It was only half the size of the living species.

Muridæ.

The rat family is represented in the miocene deposit of the *mauvaises terres* of White River by an extinct genus, to which the following name has been applied:

EUMYS.

This genus is founded upon the fragment of a jaw discovered by Professor Hayden.

Eumys elegans.—The species was about the size of the brown rat.

Hystricidæ.

The porcupine family is represented by a species whose remains were found by Professor Hayden in the pliocene sands of the Niobrara River.

HYSTRIX.

The living species of this genus are confined to the Old World, none having been discovered in America.

Hystrix venustus.—An extinct species, indicated by several isolated teeth from the Niobrara River. Judging from the characters of the teeth it was more nearly related with the crested porcupine of Europe than with our own living porcupine, pertaining to another genus.

INSECTIVORA.

The insectivorous order of animals, mainly consisting of the smallest forms of the mammalian class, as might be supposed, are among the rarest of those whose remains are found preserved in fossiliferous strata. Professor Hayden's explorations in the West have led to the discovery of three extinct genera of the order, pertaining to the miocene tertiary formation of the *mauvaises terres* of White River, Dakota, and a third genus was discovered by Dr. J. Van A. Carter, of Fort Bridger, Wyoming, in the Bridger Group of tertiary deposits of his vicinity.

LEPTICTIS.

The genus to which this name is given is established on the specimen of an almost complete skull, which was found imbedded in a soft rock near the mouth of one of the small tributaries of White River, in the *mauvaises terres.* It possessed three incisor, a canine, and seven molar teeth on each side of the jaws. The top of the skull presents a pair of prominent ridges, defining the temporal fossæ. The animal was allied more nearly to the hedgehogs than to any other of the living members of the order.

Leptictis Haydeni.—The species, named in honor of its discoverer, was scarcely as large as a mink. The skull is barely two and a half inches long.

ICTOPS.

A second genus, closely allied to the preceding, is indicated by a small fragment of a skull, found in association with the former specimen. It is distinguishable from it by difference in the form of the molar teeth.

Ictops dakotensis.—A species about the same size as the preceding, with which it lived cotemporaneously.

OMOMYS.

This extinct genus, probably pertaining to the same family as the European hedgehog, was established on the fragment of a lower jaw, with teeth, from the tertiary formation near Fort Bridger, Wyoming.

Omomys Carteri.—The species, named in honor of its discoverer, was about half as large again as our common mole, (*Scalops aquaticus.*)

EDENTATA.

Among the great multitude of vertebrate fossils brought to our notice from the western part of the continent, we have detected almost no traces of remains of the giant sloths, which existed so extensively during the quaternary period in both North and South America. Remains of *Mylodon Harlani* have been found on the Willamette River, Oregon, and recently we have seen the fragment of a claw phalanx, apparently of a large, sloth-like animal, from Castle Creek, Idaho.

CETACEA.

Remains of cetaceans, thus far, have been but sparingly found in the tertiary and quaternary formations of the West. Vertebræ from the later deposits have been indicated from Oregon.

DELPHINUS.

Remains of porpoises have been discovered in the upper miocene formation of Half-Moon Bay, California.

Delphinus occiduus.—A species, founded upon a jaw fragment from the locality just named, submitted to the examination of the writer by Professor J. D. Whitney. It was about the size of our common porpoise.

BIRDS.

The remains of birds are among the rarest of vertebrate fossils in most of the explored rocks of the world. From the peculiarities of these animals, enabling them to escape many of the catastrophes or accidents to which more terrestrial and aquatic animals would be liable, and from the generally lighter construction of their bodies, they are less likely to be placed in positions where their remains would be preserved and become fossils. Among the large collections of fossils made in the *mauvaises terres* of White River, Dakota, amounting to several tons in weight, which have been submitted to the writer's examination, he discovered no trace of birds. In all other collections from the West there was likewise no trace detected, except a single bone fragment discovered by Dr. Hayden in the pliocene sands of the Niobrara River, Nebraska. This specimen has been recently described by Professor O. C. Marsh, who views it as pertaining to an extinct species, to which he has given the name of *Grus Haydeni.*

REPTILES.

The remains of reptiles occur in the greatest abundance in the secondary formations of the West. Those best known have been derived from the cretaceous deposits of Kansas, Dakota, and of the head-waters of the Missouri River. Remains of the same order, though less abundant, are nevertheless quite numerous in the tertiary deposits of the country, especially those of turtles.

CHELONIA.

The chelonians or turtles appear to have been exceedingly abundant in the West during the tertiary period. They, however, appear not to have been so rich in the number of genera and species relatively as they do in the multitude of individuals of a few genera and species. Their remains are found in association with the numerous mammalian fossils of the *mauvaises terres* of Dakota and those of the Niobrara River. A greater number of species and genera are indicated by the remains in the tertiary deposits of the vicinity of Fort Bridger, Wyoming.

EMYS.

The genus emys includes many of our living fresh-water terrapenes, and is also represented in Europe and Asia. It has latterly been divided into different genera, founded on characters of the jaws, head, and feet; so that from the fossil shells alone we are unable more distinctly to define the animals. The shell of emys is rather oval in outline, moderately convex. The sternum is large, truncated in front, and notched behind. Its broad pedicles are joined by firm suture to the upper shell or carapace. The outer portions of the humeral and abdominal scutes cover these pedicles, and join the marginal scutes between the position of the axillary and inguinal scutes.

Emys Jeanesi.—This species is founded on a nearly complete shell, obtained, during Professor Hayden's last expedition, from the tertiary deposit of the Bridger Group, near Fort Bridger, Wyoming. The length of the shell, following the fore-and-aft curve, is fifteen inches; the length of the sternum is about one foot. The species is named in honor of Joseph Jeanes, to whose aid we have been much indebted in developing the fossil treasures of the West.

Emys Haydeni.—A second species has been inferred to have existed from an imperfect shell found in association with the former specimen, together with many fragments of shells of the same and other species of turtles. The species was about the size of the last, but is distinguished from it by the difference of form of its scute impressions.

Emys Stevensoni.—An apparent third species is founded on fragments of the carapace and sternum of a shell, obtained by Dr. J. Van A. Carter, from the tertiary deposit in the vicinity of Fort Bridger, Wyoming. It has been named in honor of James Stevenson, the active and efficient aid of Professor Hayden in his explorations.

STYLEMYS.

By this name the writer has distinguished an extinct genus of turtles, which is intermediate in form between the modern land turtles (*Testudo*) and the aquatic ones (*Emys.*) As in the former the back extremity of the carapace is invested with a broad, symmetrical plate, instead of a pair, as in the latter.

Stylemys nebrascensis.—The species is established upon specimens which have been collected by every explorer of the *mauvaises terres* of White River, Dakota. So abundant have these fossil turtles been in the locality mentioned that they have attracted the attention of the most indifferent observers. Among the specimens submitted to the examination of the author, considerable variation has been noticed, and this variation at first led to the distinction of five different species. At present he views them all as belonging to but one species. Several mature specimens measure one and three-quarter feet in length by one foot and a quarter in breadth.

Stylemys niobrarensis.—A second species has been supposed to exist, founded on a multitude of fragments, discovered by Professor Hayden in association with mammalian remains in the pliocene sands of the Niobrara River. It was as large as the preceding species.

BAPTEMYS.

An extinct genus of terrapenes, thus named, is established on an almost perfect shell, obtained from the miocene tertiary deposits in the vicinity of Fort Bridger, Wyoming. It was submitted to our examination by Mr. O. C. Smith of Amherst, Massachusetts. The genus approaches in character the existing *Dermatemys* of Central America. The pedicles of the sternum are covered by a large scute intervening between the comparatively large inguinal and axillary scutes, and separating the humeral and abdominal scutes from the marginal ones.

Baptemys wyomingensis.—The shell of the species measured about one foot and a half in length by a foot in breadth.

BÆNA.

Another extinct genus of turtles is indicated by two nearly complete shells, obtained from the tertiary formation near Fort Bridger, Wyoming. One of the specimens was discovered during Professor Hayden's last expedition; the other was presented to the writer by Dr. J. Van A. Carter, of Fort Bridger. The genus partakes of characters of the terrapenes and the snappers. The shell is moderately convex as in the latter, and like it is notched at the sides posteriorly. The sternum is more like that of the emydes than of the snappers. The sternal pedicles are deep and wide, and are impressed by one or two large scales intervening between the humeral and abdominal and the marginal scutes, and separating comparatively large axillary and inguinal scutes.

Bæna arenosa.—In its perfect condition the shell measured about fourteen inches long and about ten and a half wide. Two large scutes intervene to the axillary and inguinal scutes.

Bæna affinis.—This may, perhaps, be the same as the former. It was nearly of the same size and shape, but in the specimen which has suggested the idea of a species distinct from the former, a single accessory scute intervenes to the axillary and inguinal scutes.

TRIONYX.

The genus of soft-shelled turtles is represented by a number of extinct species belonging to both the secondary and tertiary formations of this country. Numerous fragments, in the collections of fossils obtained by Dr. J. Van A. Carter, and in those made during Professor Hayden's last two expeditions, from the tertiary deposits of Wyoming, apparently indicate two extinct species. Only one of these, however, can be characterized from the more perfect of the specimens.

Trionyx guttatus.—This species is established on a large portion of a carapace, discovered by Professor Hayden in 1868, at Church Buttes, near Fort Bridger, Wyoming. The shell of the animal was about a foot and a quarter long by a foot in breadth.

CROCODILIA.

Remains of crocodilians have not been found so abundantly in the West as might have been supposed. None have thus far been found among the multitude of other reptilian remains in the cretaceous formations of Kansas and Dakota. None have been discovered in the miocene tertiary deposits of the *mauvaises terres* of Dakota, nor the pliocene sands of the Niobrara River. One would have suspected that crocodiles would have been abundant where there were such vast numbers of mammals feeding in the vicinity of streams and lakes of fresh water, such as existed in Dakota and Nebraska during the tertiary period.

CROCODILUS.

Remains of this genus occur abundantly in the Bridger Group of tertiary formations in Wyoming. Among numerous fossils from this region sent to the writer by Dr. J. Van A. Carter, and in the collection made during Professor Hayden's last expedition, the writer has detected the remains of three species of crocodile.

Crocodilus aptus.—A species named from a single vertebra found by Colonel John A. Knight, United States Army, near South Bitter Creek, Wyoming. The animal was about the size of the Mississippi alligator. Remains apparently of the same species have been collected by Dr. J. Van A. Carter in the vicinity of Fort Bridger.

Crocodilus Elliotti.—The remains of a second species of crocodile were found in abundance, during Professor Hayden's last expedition, on one of the tributaries of Green River, Wyoming. The skull is about a foot and a half in length and bears a resemblance in shape to that of the crocodile of the Nile. The species is named in honor of Mr. Henry W. Elliott, the artist attendant on Professor Hayden's expedition. The remains of a third and smaller species of crocodile are contained in the collections made by Professor Hayden's party in the tertiary deposits of the Bridger Group. Dr. J. Van A. Carter has also sent to the author, from the same locality, a number of vertebræ of this third species.

LACERTILIA.

The cretaceous formations of the West teem with the fossil evidences of lacertilian life, forms well expressed in the line "there were giants in those days." These were, however, in many respects so peculiar, or different from the lacertilians of our day, holding as they did a position between the latter and the serpents, that Professor Cope has viewed them as characteristic of a distinct order, under the name of *Pythonomorpha.* The true lacertilians appear also to have been represented during the tertiary period, as indicated by the following genus:

SANIVA.

An extinct genus of lacertian reptiles, with the above name, is founded on remains discovered during Professor Hayden's last expedition, in a tertiary rock at Granger, Wyoming. The vertebræ, as in the living iguanas, monitors, &c., have the body excavated in a cup in front and terminating in a ball behind. The cup and ball are oblique and widest transversely. The animal possessed well-developed limbs with long toes, but the remains are too imperfect to determine their number and arrangement. The teeth were compressed, conical, and doubly trenchant, indicating carnivorous habits.

Saniva ensidens.—The species was as large as our largest living iguanas.

FISHES.

Numerous remains of fishes have been discovered in the secondary and tertiary formations of the West. Those from the secondary formations of cretaceous age belong to marine forms. Those of the tertiary formations of California, which have been described, also belong to marine forms, mainly sharks. Those of the tertiary formations east of the Rocky Mountains, which have been described, are from Green River, Wyoming, and Castle Creek, Idaho, and belong to fresh-water forms.

Cyprinidæ.

This is an extensive family of fresh-water fishes, among the least carnivorous of its class. It includes the carp, the gold-fish, the sucker, &c. It is well represented by the remains of a number of extinct species and genera in the tertiary deposit of Castle Creek, Idaho.

MYLOCYPRINUS.

An extinct genus, founded on numerous specimens of pharyngeal bones, supporting strong grinding teeth, submitted to the investigation of the author by Professor John S. Newberry.

Mylocyprinus robustus.—The large size of the pharyngeal bones with their robust grinders, looking like human premolar teeth, indicate a species several feet in length.

Cyprinodontidæ.

The living members of the cyprinodont family are small fishes, for the most part inhabiting fresh water.

CYPRINODON.

This genus is represented by an abundance of remains, discovered, in association with those of herrings, by Professor Hayden, in the tertiary shales of Green River, Wyoming.

Cyprinodon Levatus.—A small species, described by Professor Cope, from specimens obtained from the locality just named.

Clupeidæ.

The clupeoid family includes shad, herring, &c.

CLUPEA.

Several species of herrings have left an abundance of remains in the tertiary shales of Green River, Wyoming. The first of these fossils was made known to us in 1856 by the late Dr. John Evans.

Clupea humilis.—This species is about three and a half inches in length.

Clupea pusilla.—A species about half the size of the preceding and found with it described by Professor Cope.

Squammipennes.

A family of fishes characterized by the extension of scales on the fins. To it belongs the curious *Chætodon rostratus* of Java, which possesses the faculty of throwing a drop of water from its mouth, at an insect, with unerring accuracy.

ASINEOPS.

An extinct genus, established by Professor Cope on abundance of remains obtained by Professor Hayden in the tertiary shales of Green River, Wyoming.

Asineops squamifrons.—The species is about eight inches in length.

PLAGOSTOMI.

This order includes the sharks and rays.

SELACHII.

The selachians, or sharks, have left a multitude of remains in some of the marine tertiary formations of the West. From the miocene deposits of Ocoya Creek, at the western base of the Sierra Nevada, California, a number of genera and species have been indicated by Professor Agassiz, as follows: *Echinorhinus Blakei*, *Scymnus occidentalis*, *Galeocerdo productus*, *Prionodon antiquus*, *Hemipristis heteropleurus*, *Carcharodon rectus*, *Oxyrhina plana*, *Oxyrhina tumula*, *Lamna clavata*, *Lamna ornata*.

BATIDES.

The skates are indicated in the Ocoya Creek tertiary by the fragment of a tooth referred by Professor Agassiz to the genus *Zygobates*.

ONCOBATIS.

An extinct genus of rays is indicated by an osseous scale of peculiar character, from the tertiary deposit of Castle Creek, Idaho.

Oncobatis pentagonus.

The scale upon which the species is founded was discovered in association with abundance of remains of cyprinoid fishes, and is interesting as indicating most probably a large form which inhabited fresh water.

V.—ON THE FOSSIL PLANTS OF THE CRETACEOUS AND TERTIARY FORMATIONS OF KANSAS AND NEBRASKA.

By L. Lesquereux.

CHAPTER I.

ON THE MODE OF PRESERVATION OF THE FOSSIL PLANTS, AND ON THE CIRCUMSTANCES UNDER WHICH THEIR FOSSILIZATION HAS BEEN EFFECTED.

Researches for fossil plants are, in this country, so rarely undertaken under a scientific direction, that their discovery is mostly a matter of chance, giving rise to speculations and queries of a most extraordinary kind. Not only our flexuous stems of *Stigmaria* have been often considered as snakes of a prodigious size, but many times in my explorations I have been amused by preposterous questions like this one, addressed to me by people, who, recognizing a branch of fern upon a specimen of shale of the coal, wished me to explain "by what means plants of such slender size could pierce the stones and grow into them." It is not, therefore, inopportune to say a few words on the questions heading this chapter.

Every kind of woody tissue, when shut out of atmospheric influence, (or of oxidation,) either by water or by any other matter, escapes decomposition for an indefinite length of time. In such circumstances, the wood is subjected to a slow kind of combustion, of which the first state is a softening of the tissue or of the whole mass. Timber used as piling in water or in clay is found, after centuries, blackened, and more or less plastic, without any trace of decay. Whole forests of the pliocene age have been imbedded in clay, or submerged, and the trees have now their tissues as soft as the clay itself, though their structure is in a perfect state of preservation. It is the same with some deposits of lignites of the tertiary, which are a mere compound of heaped trunks of trees whose wood has become black as coal, but is still soft as clay. This first

A. L.

Unseren

freunden

G. M.

Überreicht
durch Ihre Buchhandlung

Matthew Library

May 9.

The President, Dr. Ruschenberger, in the chair.

Twenty-six members present.

The following papers were presented for publication:—

"Fourth Contribution to the History of Existing Cetacea," by Edw. D. Cope.

"Zoological and Biological Methods of Research," by Harrison Allen, M.D.

Remarks on Fossils from the Ashley Phosphate Beds.—Prof. Leidy observed that the so-called phosphate beds of Ashley ~~River, South~~ Carolina, were remarkable for the singular admixture of multitudes of fossils of different ages, from the early tertiary period inclusive down to the present epoch. The phosphatic nodules, for which the beds are explored, appear to have had their origin from the eocene rocks beneath. These have also contributed numerous remains of marine vertebrates especially of squalodonts, reptiles, and fishes. Mingled in the sand and clay with the phosphatic nodules and bones of eocene animals, are innumerable remains of cetaceans, sharks, and other marine animals of perhaps the middle and later tertiary ages. Added to these are multitudes of remains of both marine and terrestrial animals of the quaternary period. Pell-mell are found together bones of eocene squalodonts, animals related with the whales and seals; hosts of teeth of the great shark Carcharodon angustidens; myriads of the teeth of the giant of sharks of the tertiary period, the Carcharodon megalodon; bones and teeth of whales and porpoises; and abundance of remains of elephant, mastodon, megatherium, horse, etc.; and occasionally the rude implements of our more immediate ancestors.

From among a collection of fossils, from the Ashley phosphate beds, recently submitted to his inspection by Mr. J. M. Gliddon, of the Pacific Guano Company, the specimens were selected which lie upon the table. One of these is a well-preserved tooth of a Megatherium; another, a characteristic portion of the skull of a Manatee; a third, a complete tusk of the Walrus; indicating a still further point south for the extension of this animal than had been previously known; fourth, a huge tooth of a cetacean allied to the sperm whale, probably the same as those from the crag of Antwerp ascribed to Dinoziphius. Besides these there are the beaks of three cetaceans of the little known family of the Ziphioids. These are porpoise-like animals without teeth in the upper jaw, and usually with but a single pair of teeth in the lower jaw. The beaks composed of the co-ossified bones of the face are remarkable for their heat is generated, and also that antimony and tin are precipitated by heat from their nitric or other acid solutions, it was not astonishing to find those metals go into and remain in solution, by abstracting the heat with a cooling liquid in such measure as heat was generated.

In the case of tin, dilute nitric acid is known to dissolve it as protoxide, and here the water in the acid prevents the heating; in using concentrated acid and applying a cooling liquid at the outside of the vessel, the conditions remain unchanged, and only the application is different.

perhaps not astonishing, but a new fact nevertheless. G. Hay

4th. In similar circumstances, *i. e.*, after neutralization by ammonia and addition of sulphate of copper, it yielded the greenish-blue precipitate of arsenate of copper.

5th. Neutralized and then mixed with a *large* excess of concentrated hydrochloric acid and boiled with a slip of clean copper, a dark-gray film was deposited on the metal.

6th. Neutralized and added a clear mixture of sulphate of magnesia, chloride of ammonium and ammonia, it yielded at once a crystalline precipitate of arsenate of ammonia and magnesia. The original green solution was therefore either simple arsenic acid or a pentanitrate of arsenic.

The curious fact is here observed that these three metals, arsenic, antimony, and tin, when treated with cold concentrated nitric acid *kept* cold, oxidized in the relation of their several volatilities—arsenic yielding either a *penta*nitrate? or merely arsenic acid, antimony yielding a *ter*nitrate, and tin a *proto*nitrate; while the other curious fact is also to be observed that on boiling the original solutions *all* the arsenic remains in solution, a *considerable portion* of the antimony remains in solution, and *none* or only the merest trace of the tin remains in solution.

I ought to have mentioned in my last communication that the tin employed was not granulated but only cut by a sharp knife from a bar in order to prevent too rapid action of the acid upon the metal. I found it necessary on the other hand, to pulverize the antimony, as without this the action was hardly visible—the arsenic was used in large crystals.

Note upon Dr. ~~*Mr.*~~ *Hay's Paper.* By GEO. A. KOENIG, Ph.D.

The reaction of nitric hydrate upon arsenic at 36° F. results, according to the author, in the exclusive formation of arsenic acid or arsenic pentoxide. This is not substantiated by his experiments. He certainly proved the presence of the pentoxide, but does not speak of any test for the teroxide, the presence of which does not interfere much with the other reactions. It is a fact well known by chemists, that a continued digestion of the teroxide is needed with concentrated nitric acid to change it into pentoxide, and some authors state distinctly that arsenic is changed by nitric acid both into the teroxide and pentoxide.

Since it is known that by the action of nitric acid upon metals

oenig here mistakes my meaning. When I stated
it might be merely arsenic acid I did not mean that
de could not be present, but only that it yet remained
roved that it was a compound of pentoxide of

clean surface of platinum, and introduced a fragment of zinc—the result was a dark-brown or black stain of metallic antimony not removable by cold hydrochloric acid, but removable by hot nitric acid.

These four tests show that the original solution contained teroxide of antimony, and, as the solution was obtained by means of nitric acid, the probability is that it was a ternitrate of antimony, for a *large quantity* of the metal was dissolved. The HS precipitate was so bulky as at first almost to fill the test-tube.

The solution of antimony in *nitric acid kept cold* will not bear dilution with water except in presence of tartaric or hydrochloric acid.

Boiling the original green solution gave an abundant white precipitate of antimonic acid accompanied by copious evolution of orange-red fumes. Boiled till the red fumes had disappeared—diluted and filtered—the filtrate did not pass through clear, but on passing twice more through the same filter was obtained a perfectly clear filtrate. This filtrate gave every one of the four tests above-mentioned with the utmost readiness, *i. e.*, it yielded in succession tersulphide of antimony, teroxide of antimony, suboxide of silver, and metallic antimony, and therefore held in solution even after formation and precipitation of antimonic acid by boiling a *large quantity* of teroxide of antimony dissolved in nitric acid, or existing as ternitrate of antimony. In this case no other acid but the nitric had been used.

I now experimented upon arsenic in the same manner, *i. e.*, by keeping the pure metal (not pulverized) for 12 hours in contact with pure concentrated nitric acid at 36° F.

The result was a beautiful transparent green solution of the entire quantity of metal. This solution yielded every one of the tests for arsenic acid.

1st. After reduction by sulphurous acid and partial neutralization, it yielded upon addition of hydrosulphuric acid the tersulphide of arsenic.

2d. After complete neutralization, and addition of sulphide of ammonium, followed by addition of hydrochloric acid, it yielded the pentasulphide of arsenic.

3d. After addition of nitrate of silver and a small quantity of ammonia, it yielded the reddish-brown precipitate of arsenate of silver.

a soluble salt by concentrated nitric acid, but that proto-nitrate of tin is formed.

Pursuing my investigations still further with regard to the action of nitric acid upon the group of metals usually said to be oxidized, but not dissolved or converted into salts by it, I next experimented upon antimony.

Into a dry test-tube I poured about 2 c.c. of concentrated nitric acid, and then dropped into the acid about 20 grains of powdered antimony. The tube was immediately set afloat in a vessel of water at 36° F. and allowed to remain for about 12 hours, being shaken occasionally to diffuse the powder through the acid. At first there appeared to be no change produced, but by and by the fluid became distinctly green, and by the end of 12 hours a strongly green solution was obtained. On decanting this green fluid from the powdered metal and diluting it with water, a bulky and abundant white precipitate was produced, showing that a large proportion of the antimony had been dissolved in the nitric acid, and in this respect it appeared to behave like nitrate of bismuth when diluted with water. In order to ascertain in what state of combination the antimony was held, the following experiments were made.

Tartaric acid was added to the fluid containing the precipitate, and it at once dissolved to a colorless fluid.

The fluid was now filtered in order to remove any particles of undissolved metal which might have been decanted.

1st. After neutralizing a portion of the free acid in a portion of the filtrate, a strong solution of hydrosulphuric acid was added —the result was a bulky, orange-red, unmistakable precipitate of tersulphide of antimony, readily soluble in potash, and reprecipitated from its alkaline solution by dilute hydrochloric acid.

2d. To another portion of the filtrate, potash was added, and a white precipitate of teroxide of antimony was obtained soluble in excess.

3d. To the alkaline solution last obtained, nitrate of silver was added, and there was obtained a jet-black precipitate of suboxide of silver insoluble in excess of ammonia—this being distinctive of *ter*oxide of antimony.

4th. Neutralized another portion of original filtrate by ammonia to remove free nitric acid, and then acidulated with hydrochloric acid. Put a drop or two of the solution thus obtained upon a

3d. To a portion of the original solution was added solution of chloride of mercury, and in the course of a few hours a white precipitate formed consisting of sub-chloride of mercury.

4th. Chloride of gold gave no precipitate.

5th. Potash solution gave a white precipitate soluble in excess of potash.

6th. A mixture of ferricyanide of potassium and sesquichloride of iron was made, and to this mixture was added a portion of the original solution—the result was the production in a few hours of prussian blue.

These tests were, in my opinion, retarded by the presence of a large excess of nitric acid, and the production of purple of Cassius was altogether prevented by the presence of an excess of this acid. All the other tests were perfectly satisfactory.

To obviate the difficulty occasioned by the presence of a large excess of free nitric acid, a fresh solution was prepared by adding the metal to the acid until the contents of the tube had become thick and pasty, and there appeared to be little or no action going on, the tube being kept, as before, surrounded by water at 36° F.

Water was now added to the pasty mass, but in this instance a not very considerable portion of white substance was left undissolved. The solution was filtered, and to the clear filtrate was added—

1st. Hydrosulphuric acid. This yielded a brown precipitate soluble in solution of potash, and reprecipitated brown on addition of dilute hydrochloric acid.

2d. Potash yielded a white precipitate soluble in excess of potash.

3d. Chloride of gold yielded a beautiful and strong coloration of purple of Cassius after addition of a drop of dilute hydrochloric acid in five minutes, and when the tin solution was not too dilute the purple of Cassius was precipitated at once.

4th. Chloride of mercury yielded a white precipitate of sub-chloride of mercury immediately.

5th. To a mixture of ferricyanide of potassium and sesquichloride of iron, a portion of the clear filtrate was added, and almost immediately prussian blue was formed.

6th. Boiling the original filtrate caused the precipitation of the tin as hydrate of metastannic acid.

The above experiments prove that not only is tin converted into ture sufficiently high to fuse the wire at the other end under the protecting influence of the mirror already mentioned. *Within* the tube at this end I found the wire consisted of aluminium, and *outside* of the tube at the same end it consisted of platinum, which had, I suppose, been joined to the aluminium by fusion. The tin salt was undoubtedly decomposed by electrolysis even when existing as an attenuated vapor.

II. *On the Solubility of Tin, Arsenic, and Antimony in concentrated Nitric Hydrate at* 36° *F.*

The following facts have never, so far as I am aware, been published, either by myself or by any one else. I have already communicated to the Academy that the metal tin is soluble in a mixture of pure concentrated nitric acid and water in equal volumes. What I have now to communicate is, that tin forms with the undiluted acid a soluble salt, viz. the proto-nitrate of tin.

The circumstances under which the salt was formed were as follows: Into a dry test-tube I poured a small quantity of pure concentrated nitric acid, and then set the tube containing the acid afloat in a vessel of water at a temperature of 36° F. Into the acid I dropped a fragment of pure tin; it became coated with a white substance, and in the course of fifteen minutes was entirely transformed into this white substance. Several fragments of tin were added at the above intervals, and all were transformed into this white subtance. The action of the acid had now become less decided, although the fluid was still strongly acid, and the contents of the tube presented a gelatinous appearance resembling the recently precipitated hydrate of alumina. It seemed doubtful whether I had not merely obtained the ordinary hydrate of metastannic acid. Upon the addition of about two volumes of water the whole of the white substance dissolved to a clear and colorless fluid, therefore holding the tin in the solution and proving that the white substance was not the hydrate of metastannic acid.

The solution was tested as follows:—

1st. A portion was boiled and the whole of the dissolved metal was precipitated as hydrate of metastannic acid.

2d. After neutralizing a portion of the free acid, hydrosulphuric acid caused the precipitation of proto-sulphide of tin mixed with sulphur.

Treated one drop in a watch glass with hydrosulphuric acid, and got a few brownish-yellow flakes soluble in potash. Treated another drop in a watch glass with hydrosulphuric acid, and introduced fluid and flakes into a narrow tube closed at one end, and evaporated in an air bath—heated this, but only a little free sulphur sublimed, leaving a few grayish flakes in the bottom of the tube. Chased back the sulphur to the bottom of the tube, and covered it and the minute flakes with powdered dry ferrocyanide of potassium and heated again, but, as might have been expected from former experiment upon original mirror, got no mirror anew. Treated another drop with nitric acid, and got upon evaporation the slightest observable white film insoluble in nitric acid. Chloride of mercury yielded a white opalescence. The quantity of metal was so exceedingly small that, had I not experimented upon single drops, I should have got nothing in the way of a reaction. I got no reaction with gold, owing to the extreme minuteness of the quantity of metal. I do not believe that I could have weighed the quantity of metal composing this delicate mirror, but I did not attempt it. It must be remembered that all the chloride of tin within the tube originally was only a vacuum of its vapor; but it yielded the spectrum of chloride of tin, and it is well known that the spectroscope will yield certain results where ordinary chemical tests fail altogether.

The tarnished wire at the other end of the tube was not fused.

Scraped off a little of the tarnish with a penknife blade into a small watch glass and added one drop of water, but the flakes did not dissolve.

To make sure whether the drop of water mentioned had dissolved any chloride, added a small drop of nitrate of silver solution, but obtained no opalescence.

Scraped off the whole of the white tarnish and digested with a few drops of strong hydrochloric acid, and got thus a clear solution. One drop of this solution treated with hydrosulphuric acid gave no precipitate. Another drop treated with ammonia yielded a few gelatinous-looking flakes soluble in caustic potassa.

This white substance, therefore, appeared to be alumina, but, as in the case of the metal, there was extremely little of it—it had probably been chloride of aluminium, and, with the residual air or perhaps some moisture in the tube, had been converted into the oxide at the high temperature produced by the spark, a tempera-

CHEMICAL NOTES.

BY GEORGE HAY, M.D.

I. *On the Decomposition of Stannous Chloride in a Geissler Tube.*

While observing, in company with my friend, Dr. Wm. M. Herron, the spectrum of chloride of tin through a powerful spectroscope of four prisms (Browning's make)—the Geissler's spectrum-tube used for the purpose being illuminated by the spark from a large Ruhmkorff's coil connected to six cells and a Leyden jar and a tin foil condenser, the spark being capable of passing six inches in air—the following facts were noted :—

The constricted portion of the tube became hot—the spectrum became gradually feebler and feebler and ultimately ceased—a vacuum had formed within the tube so perfect that the spark would not pass.

On examining the tube I found a metallic deposit or mirror of extreme thinness, but having the well-known metallic lustre deposited upon the glass at the negative end. The wire inside of the tube at the positive end was tarnished, and had lost its metallic lustre, and was covered with a white though thin incrustation. I too hastily concluded that this was anhydrous proto-chloride of platinum, and thank Dr. Koenig for his communication correcting me, as shall appear anon. I had no time just then to investigate further—hence the mistake.

I have used up the tube in making the following observations :—

Before opening the tube I heated the end containing the mirror and found that it did not sublime.

Cut off the tube half an inch above the film, and noticed that the wire within the tube at this end was fused to a globule of the size of a pin-head adhering to the glass projecting within the tube, through which the wire passed.

Introduced one drop of concentrated hydrochloric acid, and, upon spreading this drop over the film and slightly warming, the film dissolved completely.

Rinsed out the solution with water into a small evaporating basin, and evaporated to a few drops, to concentrate as much as possible and remove the large excess of acid.

POMOXYS ANNULARIS, RAFINESQUE.

Crappie (West), New Light (Ky.) Bachelor (Falls of the Ohio).

Pomoxis annularis, Raf. Ich. Oh. 1820, 33. (Falls of the Ohio; Ky.).—Ag. Fish. Tenn. 1854, 4. (Tenn. River.)—Grd. Pac. R. R. Rep. X. 1858, 6.

" *Cantharus nigromaculatus*, Le Sueur, fide C. and V. Hist. Nat. Poiss. III. 1829, 88" (fide Grd.). (Wabash River, where Hyperistius is not found.)

Cichla Storeria, Kirt. Rep. Zoöl. Ohio, 191 (fide Kirt.).

Centrarchus hexacanthus, Kirt. Bost. Journ. Nat. Hist. III., 1840, 480, Pl. XXIX. (plate; desc. in part). (Big Miami River.)—Storer, Mem. Am. Ac., new ser. II., 1846, 290. (in part), (not of Cuv. and Val. fide Gill).

Pomoxis nitidus, Grd. Pac. R. R. Rep. X. 1858, 6 Pl. II., Fig. 5–8. (Houston River, Ky.)

Centrarchus nitidus, Günther, I. 1859, 257.

Pomoxys storerius, Gill, Pr. Phil. Acad. 1865, 64.—Cope, Pr. Am. Philos. Soc. 1870, 251. (Missouri Riv.)—Jordan, Geol. Surv. Ind. 1874, 215. (White River.)

Pomoxys brevicauda, Gill, Pr. Phila. Ac. 1865, 64. (North Grand Riv., Mo.)

Pomoxys intermedius, Gill, Pr. Phila. Ac. 1865, 64.

Pomoxys procanthus, Gill, Pr. Phila. Ac. 1865, 64. (Tarboro, N. C.)

Pomoxys annularis, Jordan, Fishes Ich. Oh.: (Bull. Buff. Soc. Nat. Hist., April, 1876, p. 89); Manual Vertebrates E. U. S. (in press)—Jordan and Copeland, Check-List N. Am. Fresh Water Fishes (in press).

Habitat.—Basin of the Ohio, Illinois, Missouri; probably in all the tributaries of the Mississippi. Not in the great Lakes? In North Carolina (fide Gill).

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